MANAGEMENT RECOMMENDATIONS

FOR

SURVEY AND MANAGE

TERRESTRIAL MOLLUSKS

Version 2.0

By

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October 1999

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SECTION NO. 1
Ancotrema voyanum
Hooded Lancetooth

Management Recommendations for *Ancotrema voyanum*, the Hooded Lancetooth (land snail)

V. 2.0

by

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EXECUTIVE SUMMARY

Species: *Ancotrema voyanum* (Newcomb, 1865) — Hooded Lancetooth (land snail)

Taxonomic Group: Mollusks

ROD Components: Protect Sites From Grazing

Other Management Status: None.

Range: *Ancotrema voyanum* is primarily known from northern Trinity County, California. In addition there are credible records for 2 disjunct locations, one in Humboldt County and one in Siskiyou County. Most records are from the Shasta-Trinity National Forests where this species is known from the Big Bar and Weaverville Ranger Districts and is suspected to occur in the Hayfork Ranger District. In the Six Rivers National Forest there are 3 records from the Lower Trinity Ranger District and one from the Orleans Ranger District. In the Klamath National Forest there is one record from the Ukonom Ranger District, and this species is suspected to occur in the Happy Camp Ranger District.

Specific Habitat: This land snail is known from intermediate elevations, 168-960 m (550-3150 feet), where it seems to be limited to the vicinity of perennial and intermittent streams. This snail seems (1) to depend on perennial subsurface dampness, (2) to be favored by late-successional conditions including old coarse woody debris, leaf mold of riparian hardwoods, and a relatively closed canopy, and (3) is possibly favored by substrates that contain limestone.

Threats: The primary threat to this species seems to be the degradation of habitat resulting from the impacts of grazing by domestic livestock. Additional possible threats come from wildfire, direct impact of prescribed fire, applied chemicals, invasion by exotic species, reduction of riparian canopy and woody debris, and concentrated recreational activities.

Management Recommendations: This is a riparian-dependent species that needs complete protection from the negative impacts of domestic livestock, which is not available under the Aquatic Conservation Strategy. If an exclosure is needed to protect identified Habitat Areas, a suggested model extends the width of the Riparian Reserve, 400 m (1/4 mile) upstream and 60 m (200 feet) downstream. For locations that are not precisely defined, a field review and a larger area may be needed to ensure adequate protection.

Information Needs: The distribution of this species is poorly known, its ecological relationships are largely unknown, and its responses to the protection of sites from livestock grazing and to other management activities need to be monitored to assess compliance with the standard and guideline and to verify the continued presence of this species.

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Ancotrema voyanum is in the family Haplotrematidae, which was named and defined anatomically by Baker (1925) and which originally included only the genus *Haplotrema* in the broad sense (Baker 1931). Pilsbry (1946) and recent taxonomic authorities (Solem 1978; Burch and Pearce 1990; Smith et al. 1990; Roth 1990 and 1991) have continued to recognize the Haplotrematidae and to place this family in the superfamily Rhytidoidea (or Rhytidacea), order (or suborder) Sigmurethra, and subclass Pulmonata.

The genus *Ancotrema* was proposed by Baker (1931) as a subgenus of *Haplotrema* with *Helix sportella* Gould (1846) as the type species. *Ancotrema* was treated as a subgenus by Pilsbry (1946) but recently elevated to a full genus by Roth (1990), who recognized 4 species in this genus. This arrangement is used by Turgeon et al. (1998).

This species was originally named as *Helix* (*Macrocyclis*) *voyana* by Newcomb (1865). Tryon (1866) and others treated *Macrocyclis* as a full genus with this species included. Ancey (1882) moved this species to the genus *Selenites*, and Pilsbry (1898) placed it in *Circinaria* before Baker (1931) moved it to *Haplotrema* (*Ancotrema*). Roth (1990) and subsequent authors use *Ancotrema voyanum* as the valid name for this species.

Newcomb (1865) did not designate a holotype. The Newcomb collection is in the Paleontology Research Institute at Cornell University. Under CU number 27961 there are 7 shells labeled as “cotypes” (= syntypes). Six are this species, and the odd shell is *Haplotrema keepi* (Barry Roth, personal communication). Until someone formally selects one specimen in the syntype series as the lectotype, there is a risk that someone might mistakenly designate the odd shell as the lectotype of *Ancotrema voyanum* and thereby create a taxonomic dilemma. Some other shells, thought to have been collected at the same time and place (part of the original series), are in the California Academy of Sciences (CAS 051593 and unnumbered) but, because they are not known to be syntypes, presumably they will not be considered for selection of the lectotype.

The type locality cannot be precisely defined. The location description with the syntype series is “Cañon Creek, Trinity County, California.” Canyon Creek (formerly Cañon Creek) runs south from the Canyon Creek Lakes to Junction City where it joins the Trinity River, an airline distance of roughly 27 km (17 miles). The original series of snail shells was collected along Canyon Creek roughly around the year 1860 by C. D. Voy (for whom this species is named). Voy was a collector of minerals, shells, and fossils in the California gold fields (Roth, personal communication). Hydraulic gold mining altered the bed of

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Canyon Creek from its mouth to the vicinity of Dedrick, a distance of roughly 16 km (10 miles). During the hydraulic mining, the local town was Cañon City, which flourished from 1851 to 1891 (in 1891 most of the townspeople moved to Dedrick to be closer to the hard-rock mines.). Although Voy may have stayed at Cañon City, the shells could have come from anywhere along Canyon Creek, and possibly they came from multiple locations although probably from within 5 miles of Cañon City. Therefore, no further restriction of the type locality seems possible.

Ancey (1882) proposed a subspecies, *Selenites voyana simplicilabris*, which Baker (1931) dismissed as a normal specimen that Ancey had contrasted to an “obscure” illustration and “impossible” measurements published by Binney (1878). Baker concluded that Ancey had not examined Newcomb's original report (Newcomb 1865).

Pilsbry (1946, page 230) proposed another subspecies, *Haplotrema voyanum humboldtense*, which he defined as a “large” variety, from Humboldt and “Klamath” counties, with a narrower spire and striation that is “strong and coarser.” Pilsbry added a footnote to explain that “Klamath County” is an extinct county (see also Chace, 1937), and the “locality” (the undefined type locality) was probably in what is now Humboldt County. Pilsbry (1946) did not designate a type specimen, but the name is available and apparently based on specimens at the Academy of Natural Sciences (dry catalog numbers 11819 from Humboldt County and 11823 from “Klamath County”) and possibly also a specimen in the Museum of Comparative Zoology (number 12083 from “Klamath County”). These specimens should be viewed as possible syntypes. According to the Known Sites database (version 2.0), one of these possible syntypes was examined by Barry Roth and identified as *Ancotrema voyanum*. This subspecies is of uncertain status (Roth, 1991 and personal communication).

The English name of this land snail is the Hooded Lancetooth (Turgeon et al. 1998). An earlier name, Voy’s Haplotreme, appeared in Baily (1935).

B. Species Description

1. Morphology

A mature *Ancotrema voyanum* has a relatively small shell with a diameter of 11 to 15 mm (Roth 1996). Mature snails in the western part of this species' range, in Humboldt and Siskiyou counties, may have shells close to 15 mm in diameter, while snails in the eastern (drier) part of the range have smaller shells that are closer to 11 mm. Ten mature shells from Canyon Creek have an average maximum diameter of 11.2 mm and a range of 10.7-11.7 mm (John Applegarth, personal observation). Mature shells have 5.0-5.5 whorls (Roth 1996) and a strongly downturned dorsal portion of the peristome or rim around the mouth of the shell. This strongly downturned dorsal lip seems to be a common feature of all species in the genus *Ancotrema*. The dorsal lip appears to droop, but actually there is an outward flaring of the slightly thickened peristome that begins at the ventral suture and almost completely encircles the mouth but stops short of the dorsal suture, giving the appearance of a crease in the dorsal lip. As a result, the shape of the mouth is an oval that is truncated on the inner (parietal) side and made somewhat sinuate by the drooping dorsal lip. Ventrally there is a small constriction just back of the outward flaring of the lip.

Shells are semi-transparent to opaque. The mineral part of the shell is pale gray or grayish white. The periostracum (the protective proteinaceous outer layer of a land snail shell) is slightly darker and amber-tinted so that shells resemble the color of weathered limestone. The form of the shell is a depressed spire on the dorsal side, and on the ventral side there is a large umbilicus that is roughly a third of the shell's diameter, but the umbilicus has been noted by Roth (1990) as being narrow relative to those of other species in this genus. The shell is relatively dull in appearance, partly because of numerous small collabral ribs (growth ridges that are parallel to the mouth of the shell). The tops of these ribs are cut by microscopic incised striae that spiral outward with the whorls and result in a very fine “beaded” texture (a feature present to some extent on shells of all species in this genus). This beaded texture is best viewed with magnification.

Externally the soft parts of this snail have a pigment pattern that is similar to but somewhat darker than that of other species in this genus. The tentacles and dorsal side of the body are dark-gray and the rest of the body is a pale gray-tan that is similar to the overall appearance of the shell. Anatomically this species can be distinguished from the closely related *Ancotrema sportella* by having the base of the spermathecal duct weakly dilated, the penial retractor muscle originating on the floor of the lung with strands from the columellar bundle, and a vagina almost equal to the length of the penis (Roth 1996). The sharp radular teeth (the basis of the English name “lancetooth”) are consistent with a carnivorous habit (Roth 1995).

2. Reproductive Biology

Baker (1941; and quoted by Pilsbry, 1946) provided the only detailed description and illustration of the reproductive anatomy of *Ancotrema voyanum* under the name *Haplotrema* (*Ancotrema*) *voyanum*. For this species there appear to be no reports on potential longevity, generation time, the number and appearance of the eggs, or the situations used for oviposition. Binney (1878) reported this species is “viviparous” (i.e., ovoviviparous). Some other kinds of snails can retain fertilized eggs in their oviducts until the eggs are ready to hatch (Barry Roth, personal communication) and, if true for this species, this might be an adaptation to the long seasonal drought and degree to which the substrate dries out. There seem to be no other published observations on reproduction in this species of snail. The behavioral aspects of copulation by this species may be similar to those described for *Haplotrema concavum* by Webb (1943). Terrence Frest (personal communication) suspects that all *Ancotrema* grow fairly rapidly and live for about 2 years, possibly a bit longer. Captive maintenance, as was done by Walton (1963, 1970) for land snails in other families, could be done for this species to provide an indication of potential life span and whether or not these snails can have multiple reproductive efforts, which could influence population stability.

3. Ecology

Ancotrema voyanum is presumed to be carnivorous. Other members of this genus have been observed to eat small slugs and earthworms (John Applegarth, personal observations). The sharp radular teeth are consistent with a carnivorous habit (Roth 1995). Except for anecdotal habitat observations, the other ecological relationships of this small land snail are unexplored. Five shells representing this species were found in the water on the bed of a small stream (location 26 in Appendix A). Possibly land snails that live where seasonal drought is severe may accidentally drown themselves, or possibly there were toxic chemicals in that stream.

C. Range, Known Sites

The Hooded Lancetooth, *Ancotrema voyanum*, seems to have a relatively small range. Within the Coast Range of northern California, this land snail has been reported from 17 mappable locations (detailed in Appendix A), of which 15 are in the northern half of Trinity County, and two are disjunct locations in adjacent parts of Humboldt and Siskiyou counties. Most records are from the Shasta-Trinity National Forests where this species is known from the Big Bar and Weaverville Ranger Districts and is suspected to occur in the Hayfork Ranger District. In the Six Rivers National Forest there are 3 records from the Lower Trinity Ranger District and one from the Orleans Ranger District. In the Klamath National Forest there is a record from the Ukonom Ranger District, and this species is suspected to occur in the Happy Camp Ranger District. Four locations are on private inholdings, and 2 locations could be on either private or Federal land. All 17 locations are along tributaries to the middle parts of the Trinity and Klamath rivers where those rivers are adjacent to the south and west sides of the Salmon Mountains (including the Trinity Alps). However, the north side of the Salmon Mountains, as well as the Marble and Siskiyou mountains to the north, seems to be less explored in terms of their land snail fauna.

There are doubtful records for Jackson County, Oregon, and Shasta County, California. Both are without further details and both are suspected of being errors. The Jackson County shell was examined by Barry Roth, so the identification is presumed to be correct. There are some tributaries of the Klamath River that reach up into the southeast corner of Jackson County, so the occurrence of this species in Oregon is a possibility. Because there are no other records from that part of the Klamath River watershed, an error of the locality data seems to be more likely. The record for Shasta County is also suspect — the identity of the shell has not been verified by an expert on Northwestern land snails, and there are no other records from Shasta County, so this record is also viewed with suspicion. Both of these records are excluded from the above description of how this species is distributed.

If this snail is now limited to isolated populations, then presumably those populations were more continuously distributed along regional rivers at some time in the past. This apparent fragmentation may have been initiated by climatic change and then recently (in historic times) compounded by human activities.

Appendix A provides an annotated list of records for this species.

D. Habitat Characteristics and Species Abundance

All known examples of *Ancotrema voyanum* have been found either near a stream or in a draw (intermittent stream channel). This fact, together with the available habitat notes, indicates this species of snail needs situations where there is permanent dampness in the substrate and, within the range of this species, suitably damp ground seems to be limited to the vicinity of stream courses. Unlike other species in the genus *Ancotrema* that live in western Washington and Oregon, this species apparently is forced to be a riparian obligate by the long summer drought. However, future observations, made in the course of surveys for other species, may find this species less restricted to riparian areas in the western part of its range where there is more rainfall.

This species seems to be favored by the presence of late-successional conditions including the presence of old coarse woody debris, a variety of riparian hardwood trees, deep leaf mold, and a relatively closed forest canopy. Habitat notes in the available records make mention of woody debris (locations 10, 18, 20, and 26 in Appendix A) and leaf mold (locations 13, 23, and 26). Trees at known sites include alder (locations 13, 16, 21, 26), bigleaf maple (21, 26), dogwood (13, 26), Douglas-fir (18, 19, 26), hazel (13, 26), madrone (18, 19, 22), and oak (18, 22). The preferred microhabitat of this snail seems to be the mat of decaying vegetation and woody debris that can be found along streams that are perennial and well-shaded by trees.

This snail may be favored by the presence of limestone in the substrate. Most of the known sites for this snail seem to be either on limestone or downstream from limestone outcrops. At one site (location 26) there are limestone nodules in the soil.

Ancotrema voyanum seems to favor intermediate elevations. This species has been found at 17 mappable locations, for each of which the elevation was recorded or is estimated in Appendix A. The average elevation for this species is 534 m (1753 feet) and the known elevational range is 168-960 m (550-3150 feet). There may be other populations situated at higher and lower elevations, but most are probably within this range. The suitable life zone for this snail may be both narrower and higher in the eastern part of its geographic distribution because there is an east-west gradient of rainfall that decreases with increasing distance from the ocean. Five western locations, outside of Trinity County to the west and north, have a vertical range of 1610 feet and a mean elevation of 1268 feet. Three eastern locations, east of the North Fork of the Trinity River, have a vertical range of 722 feet and a mean elevation of 2789 feet. Only 3 of the 17 locations are below 1000 feet elevation, only 2 are above 3000 feet, and none is above 4000 feet. This is in contrast to the higher elevational range of *Helminthoglypta talmadgei*, which has a similar geographic range.

Ancotrema voyanum is an apparently rare species that is known from a total of about 75 specimens. Its overall distribution seems to be patchy and limited to the proximity of streams and damp draws. The potential distribution of this species probably was reduced by the alteration of most of the larger streams by historic gold mining. Within the elevational range from which this species is known, the potential habitat along smaller streams probably has been reduced by the impacts of grazing by livestock. At all known sites this species seems to be scarce. With reference to Appendix A, if the type series (which could have been collected over several years) and the 6 vague records (which could represent multiple efforts) are excluded, of the remaining 21 successful collecting efforts (locations 17 and 20 were visited twice), the remaining 17 efforts each produced only 1 to 3 examples, and the mean for all 21 was 2.14 snails per collecting effort. When a species is this scarce, detecting presence can be difficult.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Protect Sites from Grazing Standard and Guideline

The Hooded Lancetooth, *Ancotrema voyanum*, seems to be scarce to rare throughout a relatively small geographic range that is entirely within the range of the Northern Spotted Owl. In the FEMAT analysis (USDA . . ., 1993, page IV-128) this species was judged to have a 50% risk of extirpation under Option

9. This snail seems to have a patchy distribution that is presently limited to the vicinity of forested streams at intermediate elevations. Gold mining activities may have eliminated this snail from along the larger streams. Most of the known localities for this species are on Federal lands. Management practices, including livestock grazing, can degrade snail habitat conditions along streams and possibly extirpate isolated populations of this species. The loss of any of the isolated populations that make up the total distribution, combined with the present inability of this species to rapidly recolonize those sites, make this mollusk increasingly vulnerable to extinction. The Aquatic Conservation Strategy permits managed livestock grazing within Riparian Reserves (USDA . . ., 1994, pages B-17 and C-33), whereas this species needs complete protection from the negative impacts of livestock grazing. In the arid environments in which it is found, impacts from grazing may be especially severe due to concentration of livestock in wet, riparian areas where colonies of this species exist.

B. Major Habitat and Viability Considerations

Within the range of *Ancotrema voyanum*, most of the landscape seems to be quite uninhabitable for this species because of long seasonal drought and the depth to which the ground becomes dry. The original dispersal corridors may have been along the margins of streams or this species may have been isolated there by climatic change. The present margins of regional streams probably have been degraded as mollusk habitat by gold mining and livestock grazing. In contrast to other land animals, terrestrial mollusk populations have low mobility and are relatively sedentary through geologic time, so a major concern in the conservation of this species is its relative inability to recolonize areas that may have recovered their potential as habitat. Therefore, the long-term survival of this species depends heavily on managing for the survival of the existing colonies. As noted by Roth (1993), “if protected from catastrophes, snail colonies may not depend on immigration and could conceivably be self-sustaining for centuries, in which case the distance to the next fragment [of suitable habitat] may not be very important.” What is most urgent is finding and conserving the presently inhabited locations. Roth (1993) concluded that “even patches of a few hundred square meters could support 'reservoir' populations if appropriate habitat structures . . . were maintained.” However it should also be recognized that the long-term survival of this species will depend on the health of the local ecosystem that in turn depends on connectivity with adjacent communities, both terrestrial and aquatic.

C. Threats to the Species

The most serious threat to the survival of *Ancotrema voyanum* seems to be the loss of adequately damp conditions at the inhabited locations. Livestock grazing can threaten the local survival of this species in a number of ways, including (1) the trampling of snails that are under the leaf litter or in spaces within the upper part of the soil, (2) the reducing of the supply of the herbaceous plants on which other invertebrate animals feed, including those species that are consumed by this predatory species, (3) the consuming of tree seedlings that are needed to provide future canopy trees, (4) the loss of perennial subsurface dampness wherever the removal of vegetation by grazing results in faster runoff and in more sunlight and wind drying out the ground, (5) the degradation of water quality and flow patterns from a grazed area, and (6) the loss of the relatively cool and damp microclimate created by the natural vegetation. In view of the stress already imposed by the long seasonal droughts of the present climate, these threats could result in extirpation of the apparently small and isolated populations of this rare land snail, especially in areas of concentrated use by livestock in riparian areas.

Other threats could come from the removal of trees within Riparian Reserves that will allow more sunlight and wind to reach and dry out the ground. Prescribed fire within inhabited areas may reduce the shade-providing canopy vegetation, reduce the quantity of leaf mold and herbaceous plants, degrade existing woody debris, and may result in direct mortality. Prescribed fire outside of inhabited areas may reduce the risk of extirpation as a result of wildfire. Any chemicals applied in inhabited areas, including firefighting chemicals, fertilizers, herbicides, and pesticides, may be directly toxic or adversely impact the habitat of the prey of this species. Invasions by exotic species could ecologically threaten the local survival of this species. Concentrated recreational activities, especially amateur gold mining, could be harmful to this species as a result of people and vehicles compacting the ground, use of woody debris for firewood, wildfires starting from campfires, and alteration of the streambed.

D. Distribution Relative to Land Allocations

Of the known locations for *Ancotrema voyanum* (in Appendix A), 2 locations are within the Trinity Alps Wilderness (locations 11 and 23), 5 are within the Hayfork Adaptive Management Area (locations 12-14, and 18-19), and 7 are within a quarter mile of the Klamath, Salmon, or Trinity rivers so they should be within Wild and Scenic River Areas (locations 10, 13-14, 17, 22, and 24-25).

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The goal for management of the Hooded Lancetooth, *Ancotrema voyanum*, is to assist in maintaining the viability of known and newly discovered populations of this species.

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B. Specific Objectives

The specific objectives for *Ancotrema voyanum* should be to identify and manage inhabited locations, maintaining the ecological framework in which this species can function as a natural component, so this species will have the opportunity to persist on a long-term basis. The specific management objectives for protection from grazing should include the following:

- Avoid the direct trampling of snails that are within the leaf litter and soil.
- Conserve the natural abundance of herbaceous plants on which prey species feed.
- Conserve tree seedlings so they can naturally replace the present canopy trees.
- Conserve subsurface dampness by maintaining the natural riparian vegetation.
- Protect riparian sites from upstream changes in water quality and flow patterns due to overgrazing.
- Conserve the relatively cool and damp micro-climate created by local vegetation.

IV. HABITAT MANAGEMENT

A. Lessons from History

There seem to be no reports on populations of *Ancotrema voyanum*, or any other species of *Ancotrema*, that have been studied over either a range of time or a range of conditions so that inferences could be drawn concerning population responses and limiting factors. However, habitat degradation as a result of grazing and gold mining is believed to have contributed to the apparent isolation of the known populations.

B. Identification of Habitat Areas for Management

Occupied known locations and newly discovered sites for *Ancotrema voyanum* that are on Federal land and are defined with adequate precision should be managed by means of Habitat Areas. In Appendix A there are 6 known locations on Federal land that seem to be defined to within 46 meters or 150 feet ("precisely defined"). Surveys and casual observations may discover some additional sites that are also precisely defined. However, there are 7 more locations in Appendix A (13, 16-19, 22, and 25) that are not precisely defined *but* they are definitely or possibly on Federal land (locations 16 and 17 might be on private land) and seem to be defined within 400 meters (one quarter mile) along a particular stream. Because there are few known locations, suitable looking habitat at those additional 7 locations should be managed, if possible, in such a way that would favor the local survival of this species. Verification of the presence of this species and an assessment of the extent of available habitat could help with the identification of Habitat Areas for any locations that are less than precisely defined.

According to the interagency ROD (USDA . . ., 1994, pages C-4 and C-5), “in most cases the appropriate action will be protection of relatively small [Habitat Areas], on the order of tens of acres.” If a site is precisely defined and is located in a Riparian Reserve, then a suggested model for a favorable Habitat Area for this species would include at least the width of the Riparian Reserve (USDA . . ., 1994, pages C-30 and C-31), would extend at least 400 meters (one quarter mile) upstream, and would extend at least 60 meters (200 feet) downstream from a marked site, unless otherwise limited by ownership, topography, or major (paved) roads. A rectangle so defined would enclose roughly 7 acres (2.8 hectares), which is somewhat less that the area suggested by the ROD. The suggested upstream distance is intended to provide a buffer for water quality and is based on the response of Tailed Frog tadpoles to in-stream buffers (John Applegarth, personal observations). The width and downstream distance are mainly to conserve shade and are based on Chen (1995, figure 8c) and the FEMAT report (USDA . . ., 1993, page IV-135, mitigation for mollusks, last sentence of paragraph 1). Locations that are in draws without a permanent surface stream or are outside of any Riparian Reserve should be managed with a Habitat Area that has a similar area but is shaped to enclose the most promising potential habitat in that vicinity. For less than precisely defined locations, larger Habitat Areas may be needed in some cases to ensure that the original site and the associate snail population are adequately protected.

C. Management Within Habitat Areas

Occupied known and newly discovered locations for the Hooded Lancetooth land snail, *Ancotrema voyanum*, need to be completely protected from the negative impacts of grazing by domestic livestock. This should be accomplished by keeping all domestic livestock out of Habitat Areas that are identified for this species. If this exclosure is accomplished by means of a fence, then the use of permanent fencing is suggested because all locations seem to be below 1000 meters (3281 feet) elevation and because of the risk that drop-fences might not be put up before livestock arrives each spring.

D. Other Management Issues and Considerations

Although grazing impacts are considered the major threats to this species, other issues should be considered when managing for this species. Fire can result in loss of shading, loss of windbreak, loss or degradation of woody debris and leaf mold, and loss or reduction of other invertebrates (slugs and earthworms on which this snail predates). Reduction of hazardous fuels by means of prescribed fire on lands outside of Habitat Areas should favor this species by reducing the risk of wildfire causing catastrophic habitat loss within Habitat Areas. If any lands (including non-Federal lands) adjacent to a fenced Habitat Area are to be managed by fire, then the construction of adequate firebreaks may be needed to keep fire from entering the Habitat Area (there should be room for a firebreak between a fence and a property line *or* the firebreak will need to be within the fence that protects a Habitat Area). In general, populations of this rare snail seem to be isolated, so a wildfire in an inhabited riparian corridor could result in the local extirpation of this species. The chance of this species recovering after a wildfire may be proportional to the extent to which parts of the habitat are missed by the fire.

When evaluating the objectives for the Aquatic Conservation Strategy in Riparian Reserves, which are occupied by this species, other activities or silvicultural treatments that may adversely affect this species should be considered. Amateur gold mining and other concentrated recreational activities may cause adverse effects within Habitat Areas. Chemicals, including herbicides and pesticides, may be harmful to this and other mollusks.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

The Hooded Lancetooth, *Ancotrema voyanum*, has not been the subject of any special study. Its distribution is poorly explored, its ecology is largely unknown, and its response to management activities can only be inferred at this time. Although surveys for this species are not required by the ROD (*Ancotrema voyanum* is not listed in Table C-3, USDA . . ., 1994), if this snail were to be found either by chance or in the course of surveys for other mollusks, the details about the location and habitat are needed for a better understanding of this species. In the future, if additional locations are discovered on Federal land and are managed under the “protect sites from grazing” standard and guideline, then the risk of the accidental loss of any populations, known or unknown, becomes less of a threat to the long-term survival of this rare species.

B. Research Questions

Does *Ancotrema voyanum* occur together with other species in this genus?
Is the east-west gradient in shell size due to genetic or environmental differences?
What are the natural preferred foods and major predators of this small snail?
What methods might help in the detection and monitoring of this rare snail?
How long can individual snails of this species live (as tested in captivity)?
What is its reproductive “resilience” (how fast can populations recover)?
To what extent does this snail benefit from the presence of limestone in the alluvium?
Are there any plants that can serve as indicators of the possible presence of this snail?
Are there any exotic plants or animals that could threaten the survival of this species?
Were the known populations isolated by historic degradation of main streams?

C. Monitoring Needs and Recommendations

Historic sites should be verified, and exact site locations mapped. Occupied known and newly discovered locations should be monitored to assess compliance with the “protect sites from grazing” standard and guideline, to evaluate the habitat impacts of all management activities in and near these locations, and to verify the continued existence of this species within each managed location. It is suggested that monitoring be limited at most locations to detecting presence and only when season and conditions are otherwise favorable for protocol surveys for other terrestrial mollusks. This is because efforts to find this species at a particular location may mean considerable disturbance to the woody debris and leaf mold. Although rocks, woody debris, and leaf mold should be replaced as much as practicable, limiting the search only to detecting presence is intended to minimize any degrading of the habitat.

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APPENDIX A

The following annotated list includes all records for *Ancotrema voyanum*. In the Known Sites Database (version 2.0) there are 64 records for this species. Thirty of those records do not represent this species and should be deleted (invalid records have ID numbers 97000001-97000002, 97000014, 97000023-97000024, 97000027, 97000073-97000075, 97000080, 97000085, 97000087-97000089, 97500029-97500035, 97500054-97500060, and 97600001-97600002). In the following list the remaining 34 records are grouped into 25 locations, and there is an additional location not in the database. The first location is the type locality, and the rest are arranged by the first date they were visited (records without dates are thought to be older and are placed ahead of those records with dates).

After the location number (and Record ID numbers from the Known Sites Database) there is a brief description of the location, the date(s) of collection, and the number of specimens (with the museum acronym or name of the holder and their catalog number, if any). The annotation includes any corrections or questions, an estimate of UTM coordinates, an estimate of elevation, the USGS 7½-minute topographic map, land ownership, and level of precision code (plus original code if it seemed incorrect). In the Known Sites database, all records were graded as to how accurate the description of location seemed to be, and that code was entered in the precision field. These codes are S = second record (location accurate to ±150 feet), M = minute record (accurate to ±1.5 miles), G = general record (accurate to ±5 miles), and V = vague record (cannot be located within ±5 miles). The "**mappable**" locations are hereby defined as records with level M or S precision.

#1 (record ID 97000003, 97000078, 97000082, 97000083) **Type locality —** California, **Trinity County**, **Canyon Creek**. No date. 10 specimens (Cornell University 27961 — 6 shells including a specimen of *Haplotrema keepi*; plus several other lots that are suspected of being from the original series collected by C. D. Voy around 1860 — including CAS 51593 and unnumbered, SBMNH unnumbered, and possibly UCBMP 2504). USGS map = Dedrick, CA, 1982; land ownership is mixed (private, Bureau of Land Management, and Shasta-Trinity National Forests); and precision = G.

#2 (97500010) **California** [no county]. No date. Two specimens (MCZ 12082), collected [or donated] by Newcomb. MCZ label states they are "cotypes" of *Helix voyana* Newcomb, 1865, but are not known to have come from the type locality; precision = V.

#3 (90101715, 90101718, 97500011) California, **Klamath and Humboldt counties**. No date. Total of 5 specimens (ANSP 11819 and 11823, and MCZ 12083). These are possible syntypes of *Haplotrema voyanum humboldtense* Pilsbry, 1946 (see discussion of this subspecies in section I-B, above); precision = V (not M).

#4 (90101717) California, **Shasta County**. No date. One specimen (ANSP 1893). The longitude and latitude values (in the Known Sites database) are not part of the original data set and seem to represent the center of the county, so precision = V (not M).

#5 (97000072, 97000076, 97000077) California, **Trinity County**. No date. A total of 5 specimens (UCBMP 2504). Precision = V.

#6 (97000079) Oregon, **Jackson County**. No date. One specimen (UCBMP R-1287). Identified by Barry Roth, so there is a possibility this species is represented in southern Oregon, but an error in the locality information seems more likely; precision = V.

#7 (97000086) California, **Trinity County**, **Canyon Creek**. 1931 June. One specimen (CAS 50756). Unlike the type series collected by C. D. Voy, this specimen was collected about 70 years later (by G Dallas Hanna), so research may be able to further restrict this location; land ownership is mixed (private and Federal); and precision = G.

#8 (90084431) California, **Trinity County**, half a mile **north of Trinity Alps Camp**. 1931 June. Three specimens (ANSP 177545 and A-15757). This collection was reported by Baker (1941), who described the location as "along a small creek entering Stuarts Fork, Trinity River, ½ mile north of Trinity Alps Camp" (now Trinity Alps Resort in SE/4 of section 28, T. 35 N, R. 9 W). Apparently this site is on Trinity Alps Creek; if airline distance is used then this site is in NE/4 of section 28 where UTM would be about 509400 E and 4523600 N and elevation roughly 850 meters (2790 feet); USGS map = Rush Creek Lakes, CA, 1982; land ownership is private; and precision = M.

#9 (97000084) California, **Trinity County**, **French Gulch Creek** northwest of Weaverville. 1942 summer. Five specimens (CAS 69272). Barry Roth (Known Sites database version 2.0) speculated this was French Gulch (section 8, T. 36 N, R. 11 W) that is in Trinity County, northwest of Weaverville, and not the French Gulch in Shasta County to the east of Weaverville. However, French Gulch in Trinity County is remote from roads and reached by a hike of at least 4 miles up the North Fork of the Trinity River. Furthermore, there are other possibilities — "French Gulch Creek" could refer to French Creek (28 road miles west of Weaverville), or this could have been a gold-mining site near Weaverville that is not labelled on current maps — so the precision = V (not M).

#10 (95000053) California, **Trinity County**, opposite Salyer, **Scharpers Slough**. 1960 June 7. One specimen (Roth 1094). "Scharpers Slough" apparently is the sluggish part of Sharber Creek that is close to the north bank road before this creek enters the Trinity River; this location is north of a residential area but roughly a mile east of the bridge at Salyer; UTM are roughly 452400 E and 4527400 N; elevation is roughly 168 meters (550 feet); USGS map is Salyer, CA, 1979; land is private; and precision = M (not G).

#11 (95000065) California, **Trinity County**, **Virgin Creek**. 1960 September. One specimen (Roth 1092). Virgin Creek is about a 2-mile hike from the end of the road along New River. Elevation at the mouth of Virgin Creek is about 610 meters (2000 feet); USGS map = Dees Peak, CA, 1978; land ownership for all of Virgin Creek is Federal (Shasta-Trinity National Forests, Trinity Alps Wilderness); and precision = G.

#12 (95000055) California, **Trinity County**, **Swede Creek** just north of Big Mountain Road crossing, SW/4 of NW/4 of section 23 [error for section 13], T. 5 N, R. 7 E. 1978 May 25. Two specimens (Roth 998). UTM are about 470710 E and 4517290 N; elevation is about 510 meters (1673 feet); USGS map = Del Loma, CA, 1982; land is Federal (Shasta-Trinity National Forests, Hayfork Adaptive Management Area); precision = S.

#13 (95000061) California, **Trinity County**, **west bank of Swede Creek** about a third of the way up the road to the Olasson Ranch, stream terrace below road, NE/4 of NE/4 of section 23, T. 5 N, R. 7 E. 1978 May 25. Three specimens (Roth 994). UTM are roughly 470140 E and 4516030 N; elevation is about 370 meters (1214 feet);

USGS map = Del Loma, CA, 1982; land is Federal (Shasta-Trinity National Forests, Wild and Scenic River Area, and Hayfork Adaptive Management Area); and precision = M (not S).

#14 (95000056) California, **Trinity County**, **Big French Creek**, west bank, first large terrace north of State route 299, SW/4 of SW/4 of section 20, T. 5 N, R. 8 E. 1978 May 26. Two specimens (Roth 999). Site is "roughly 150 meters north of highway" according to the collector, Barry Roth (1996 August phone call), but the SW corner of section 20 appears to be closer to 400 meters north of the highway (if the first large terrace is obvious in the field, this location could be redefined with S level of precision); UTM are roughly 474070 E and 4514430 N; elevation is about 345 meters (1132 feet); USGS map = Del Loma, CA, 1982 (no section lines); land is Federal (Trinity National Forest, Wild and Scenic River Area, and Hayfork Adaptive Management Area); precision = M (not S).

#15 (95000054) California, **Trinity County**, first **switchback south of Big Bar**, where Forest Service road 4N16 crosses an unnamed creek in SE/4 of SW/4 of section 6, T. 4 N, R. 8 E. 1980 August 31. One specimen (Roth 1206). This is in T. 33 N, R. 12 W, Mount Diablo Meridian (not T. 4 N, R. 8 E, Humboldt Meridian); UTM are about 477100 E and 4508750 N; elevation is about 570 meters (1870 feet); USGS map = Big Bar, CA, 1982; land is Federal (Shasta-Trinity National Forests); and precision = S.

#16 (95000057) California, **Trinity County**, unnamed **tributary to McDonald Creek**, at Forest Service road 60 south of Burnt Ranch, in NW/4 of section 22, T. 5 N, R. 6 E. 1980 August 31. Two specimens (Roth 1205). UTM are roughly 458200 E and 4516500 N; elevation is roughly 760 meters (2493 feet); USGS map = Ironside Mountain, CA, 1982; land is private *or* Federal (Shasta-Trinity National Forests); and precision = M.

#17 (95000058, 95000060) California, **Trinity County**, **Don Juan Creek**, "for 0.25 mile" [from 0.0 to 0.25 mile] north of State route 299, SW/4 of section 20, T. 5 N, R. 7 E. 1980 October 26 *and* 1992 April 7. Two specimens (Roth 1218 and 1757.2). UTM are roughly 464300 E and 4515200 N; elevation is roughly 340 meters (1115 feet); USGS map = Ironside Mountain, CA, 1982; land ownership is private *or* Federal (Shasta-Trinity National Forests, Wild and Scenic River Area); and precision = M (not S).

#18 (95000063) California, **Trinity County**, **Hawkins Creek drainage** along Forest Service Road 7N01 [county road 402] in NW/4 of NW/4 of section 22, T. 6 N, R. 6 E. 1981 February 16. One specimen (Roth 1234). UMT are roughly 458300 E and 4526000 N; elevation is roughly 640 meters (2100 feet); USGS map = Denny, CA, 1982; land ownership is Federal (Six Rivers National Forest); and precision = M (not S).

#19 (95000051) California, **Trinity County**, **Hennessy Ridge Road**, 2.3 road miles up from start of Forest Service road 6N12, center of SW/4 of section 30, T. 6 N, R. 6

E. 1981 February 16. Two specimens (Roth 1235). UTM are roughly 453600 E and 4523600 N; elevation is roughly 658 meters (2160 feet); USGS map = Hennessy Peak, CA, 1979; land is Federal (Six Rivers National Forest); and precision = M (not S).

#20 (95000062, 95000064) California, **Trinity County**, **Bidden Creek** near Forest Service road 4N47, in SW/4 of SE/4 of section 19, T. 4 N, R. 8 E. 1981 May 9 *and* 1981 October 2. Two specimens (Roth 1229). Probably within the *Monadenia setosa* study area that is about 50 meters north of Forest Service road 4N47 (Roth and Pressley, 1986, page 173); UTM are about 473610 E and 4505590 N; elevation is about 955 meters (3133 feet); USGS map = Big Bar, CA, 1982; land ownership is private; and precision = S.

#21 (95000066) California, **Trinity County**, **0.2 km east of Price Creek**, south bank of Trinity River, in SW/4 of NE/4 of section 5, T. 33 N, R. 12 W. 1981 October 3. Two specimens (Roth 1402). This is the type locality for *Vespericola pressleyi* Roth (1985); UTM are about 479050 E and 4509560 N; elevation is about 370 meters (1214 feet); USGS map = Hayfork Bally, CA, 1982; land ownership is private; and precision = S.

#22 (95000052) California, **Siskiyou County**, **2.7 road miles east of Somes Bar**, via the Etna-Somes Bar Road east of the junction with State route 96, along small stream entering north side of the Salmon River. 1984 May 17. Five specimens (Roth 1439). Mileage is closer to 2.8 road miles; this is an ephemeral stream in a small draw that is shown on the Klamath National Forest map but not the USGS map (stream was dry when visited by John Applegarth on 1996 August 22); UTM are about 462860 E and 4580470 N; elevation is about 219 meters (720 feet); USGS map = Somes Bar, CA, 1979; land ownership is Federal (Klamath National Forest); and precision = S (not G).

#23 (97000025) California, **Trinity County, Canyon Creek Trail** at the first stream crossing above trail head, north [NNE] of Dedrick. 1987 June 3. One specimen (SBMNH Miller Collection 7644). This location is on Bear Creek in section 17 (not 19); UTM are about 498330 E and 4526480 N; elevation is about 960 meters (3150 feet); USGS map = Mount Hilton, CA, 1982 (no section lines); land ownership is Federal (Shasta-Trinity National Forests and Trinity Alps Wilderness); and precision = S (not M).

#24 (97000026) California, **Trinity County, Manzanita Creek**, along banks just upstream from Highway 299, NE/4 of section 5, T. 33 N, R. 12 W. 1992 April 7. Four specimens (SBMNH Miller Collection 8113). UTM are about 479460 E and 4509670 N; elevation is about 380 meters (1247 feet); the USGS map = Hayfork Bally, CA, 1982; according to the Shasta-Trinity National Forests map the land ownership is Federal (Shasta-Trinity National Forests and Wild and Scenic River Area); and precision = S.

#25 (95000059) California, **Humboldt County**, **Red Cap Gulch**, “for 0.1 mile” [from 0.0 to 0.1 mile] north of State route 96. 1992 April 9. Five specimens (Roth 1761.2). UTM are roughly 449200 E and 4569500 N; elevation has a range of 232-

262 meters (760-860 feet); USGS map = Orleans, CA, 1978; land ownership is Federal (Six Rivers National Forest and Wild and Scenic River Area); and precision = M (not S).

#26 (not in version 2.0) California, **Trinity County**, **north side of Grasshopper Flat**, along a small stream, from Canyon Creek Road (county road 401) to about 20 meters west (upslope); 5 shells were in stream water, and 2 shells and 1 live snail were in the leaf mold under woody debris in the shade of several bigleaf maple trees on adjacent north-facing slope. 1996 August 23. Eight specimens (Applegarth uncatalogued -- collected by John Applegarth and daughter Diana). UTM are 496210 E and 4522590 N; elevation is about 740 meters (2428 feet); USGS map = Dedrick, CA, 1982; land ownership seems to be Federal (Shasta-Trinity National Forests); and precision = S.

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SECTION NO. 2
Cryptomastix hendersoni
Columbia Oregonian

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Management Recommendations
for
Cryptomastix hendersoni, the Columbia Oregonian (land snail)

V. 2.0

by

John S. Applegarth

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Species: *Cryptomastix hendersoni* (Pilsbry, 1928) — the Columbia Oregonian (land snail)

Taxonomic Group: Mollusks

ROD Components: Survey Strategies 1 and 2

Other Management Status: In Oregon this species is on List 1 of the Oregon Natural Heritage Program and, therefore, is a Bureau Sensitive species for the Bureau of Land Management. In Washington this species is on the Washington State Monitor Species List and, therefore, is a Bureau of Land Management Tracking Species.

Range: Although historical sites for *Cryptomastix hendersoni* are outside the range of the Northern Spotted Owl, recent surveys have found what appears to be this species within the range of the owl. This snail is known from 13 locations at seeps and streams along both sides of the Columbia River, from near The Dalles to near Rufus. There are a few specimens that appear to represent this species from six upland locations in the Mount Hood National Forest.

Specific habitat: *Cryptomastix hendersoni* was originally known from the margins of a few seeps and spring-fed streams, at low elevation at the east end of the Columbia River Gorge, where this snail finds shelter under rocks and herbaceous vegetation along sun-lit margins of streams, presumably feeds on algae and herbaceous vegetation, and lives where there are few or no trees. In contrast, new mid-elevation records that appear to represent this species are from mature hemlock forests at several locations, at 792 and 1000 m (2600 and 3280 feet) elevation, where most snails were found under woody debris under a relatively closed canopy.

Threats: Along the Columbia River the threats to this species include the impoundment or diversion of spring-fed streams, and the loss of edible plants and clean water as a result of livestock grazing or pollution. At higher elevations in coniferous forests, what appears to be this species is not limited to stream margins and may be more dependent on old woody debris and the cool and damp microclimate that is provided by a relatively closed forest canopy.

Management recommendations: In mid-elevation forests (under the Northwest Forest Plan), this species seems to be rare, so the habitat structure and damp microclimate should be conserved in Habitat Areas of ten or more acres. Along the Columbia River, if this snail is on Federal land (not under the Forest Plan), it could be favored by removing livestock and exotic vegetation from inhabited riparian zones, and by conserving perennial flow at occupied sites.

Information needs: Both this species and its genus need to be better defined anatomically. Snails that appear to represent this species from mid-elevations in the Mount Hood National Forest need to have their taxonomy, ecology, distribution, and abundance explored.

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Pilsbry (1939, 1940) and most subsequent authors (Turgeon et al., 1998) have placed *Cryptomastix* in the pulmonate snail family Polygyridae, which was originally proposed as a subfamily by Pilsbry (1895). A recent exception is Burch and Pearce (1990) who used Mesodontidae for this family and treated Polygyridae as a junior synonym.

The genus *Cryptomastix* was originally proposed as a subgenus of *Triodopsis* by Pilsbry (1939, page xvii). Vagvolgyi (1968) noted that *Cryptomastix* might be considered a genus on the basis of anatomy and distribution, but chose to follow the existing subgeneric status because his work was focused at the species level. However, *Cryptomastix* has been treated as a full genus by Webb (1970) and subsequent authors. Webb (1970, 1990) made *Cryptomastix hendersoni* the type species of a new subgenus, *Bupiogona*, based on his observations of their reproduction. Frest and Johannes (1995, 1996) view the subgenus as biologically valid but recognized the snails studied by Webb as *Cryptomastix populi*, not *Cryptomastix hendersoni*, so they treated this species as *Cryptomastix* (*Cryptomastix*) *hendersoni* (Pilsbry 1928). A type species based on a misidentification is a problem that should be resolved by the International Commission on Zoological Nomenclature under Article 70(b) of the Code (ICZN, 1985).

Cryptomastix hendersoni was originally proposed as a subspecies of *Polygyra mullani* by Pilsbry (1928), who stated the type specimen had been collected by Henry Hemphill “near the Dalles” but provided an incorrect Academy of Natural Sciences catalogue number. Later, Pilsbry (1940) classified this snail as *Triodopsis mullani hendersoni* and cited the correct catalog number for the type specimen (ANSP 145479). Pilsbry (1940) changed the description of the type locality (the source of the type specimen) from “near the Dalles” to “The Dalles.” Henry Hemphill, who lived from 1830 to 1914, apparently collected the type specimen and over 80 other specimens of this snail from this location, possibly over several dates or years. At the turn of the century the name of the nearest town was often considered quite adequate for a locality description, so this series could have come from either in or near The Dalles.

Vagvolgyi (1968) treated *Polygyra mullani hendersoni* Pilsbry (1928), together with five other subspecies that were recognized by Pilsbry (1940) plus *Triodopsis populi*, as synonyms of *Triodopsis mullani mullani* (Bland and Cooper 1862). Vagvolgyi based this taxonomic action on the shell morphology of only 11 samples of what he considered *Triodopsis mullani mullani*, with 1-11 specimens of each and only 37 specimens altogether. Since that taxonomic “lumping” action, the “splitters” have prevailed. Webb (1970) recognized

Cryptomastix hendersoni as a full species, and that status has been followed by subsequent authors (e.g., Turgeon et al. 1998).

Frest and Johannes (1995) concluded that all records for this species from the Blue Mountains and the Hells Canyon area actually represent other species that are outside of the range of the Northern Spotted Owl and, therefore, not of concern within the Northwest Forest Plan. However, specimens recently found in the Mount Hood National Forest (details in Appendix A) do appear to represent this species. The only published definition of this species is by Pilsbry (1928, 1940) who only refers to shell morphology. The new shells fit Pilsbry's description of this species "to a T" (Thomas Burke, personal communication). No specimens have been dissected to see if they are anatomically the same as *Cryptomastix hendersoni* from the type locality. Anatomical and biochemical analyses may eventually show these new snails to be a distinct race within this species, which could be named as a subspecies. Although the snails in Mount Hood National Forest could ultimately prove to be a separate but closely related species, they should be viewed as part of this species as understood at the time the interagency ROD was signed and, therefore, remain within the mandates of the Survey and Manage standard and guideline (according to an interpretation provided for other ROD species by Randy Hickenbottom, personal communication).

As of January 1999 there are no subspecies. Prior to the discovery of what appears to be this species in the Mount Hood National Forest, no division of this species was anticipated. In other words, there is a possibility that the populations in the Mount Hood National Forest eventually could be classified as a subspecies of this species.

B. Species Description

1. Morphology

Cryptomastix hendersoni develops a moderately small shell that can be 15 to 20 mm in diameter on maturity (Frest and Johannes 1996). Five mature examples from Rowland Spring (location #5 in Appendix A) are 15 to 17 mm in maximum diameter (John Applegarth, personal observation). There are black-and-white photos of the holotype and a paratype shell in Pilsbry (1928, 1940). The shell of a live snail is brown, which is the color of the periostracum (the protective proteinaceous outer coating), except where it is damaged to reveal the gray mineral part of the shell. Empty shells exposed to sunlight and moisture will become bleached and chalky white. There is no trace of hairs (setae), papillae, or hair scars on the outer whorls. The shape of the shell is a moderately depressed spire. The ventral opening or umbilicus is shallow and small, being about a tenth of the diameter of the shell. At maturity there will be 5 to 5½ whorls and an outward flaring of the mouth of the shell that is fairly typical of members of the family Polygyridae. On maturity there will be a constriction of the last whorl followed by a strong outward flaring that becomes thickened and may continue to curve back until it nearly touches the outer wall of the last whorl. The lip that is produced by this outward flaring is white or nearly so. There are growth ridges that are more pronounced on the dorsal side of the shell, and there are faint spiral ridges that cross the growth ridges. Pilsbry (1928) described this snail as being "toothless" and that is true in his photos of the type and paratype from The Dalles. However, snails of this species from the Washington side of the Columbia River (Rowland Spring, which is location #10 in Appendix A) do have a small parietal "tooth" or lamella (as defined by Roth, 1996). This character seems to vary, as noted by Pilsbry (1940) and Frest and Johannes (1996).

Pilsbry (1928, 1940) defined *Cryptomastix hendersoni* only of the characteristics of shell morphology. The soft parts of the living snail are a pale grayish tan, with darker pigment in the ocular tentacles and their retractor muscles (John Applegarth, personal observation and photographs). Frest and Johannes (1996) note that closely related taxa (*Cryptomastix mullani mullani*, *Cryptomastix mullani olneyae*, and *Cryptomastix populi*) have dark bodies. They consider "*Cryptomastix hendersoni*" from Idaho and eastern Oregon as representing other species that have similar shells but anatomically represent distinct biological entities. These anatomical differences and the taxa that they define have not been reported. Also, no anatomical details have been reported for the specimens from the Mount Hood National Forest.

There are no published descriptions or illustrations of the anatomy of *Cryptomastix hendersoni*. Webb (1970, 1990) made observations on the courtship and copulation of snails he thought to be *Cryptomastix hendersoni* and, on that basis, he proposed a new subgenus, *Bupiogona*, with *Cryptomastix hendersoni* as the type species. According to Frest and Johannes (1995), the taxonomic proposal by Webb is based on a valid biological discovery, but the species observed and shown in the photographic illustrations is *Cryptomastix populi*, not *Cryptomastix hendersoni*. Frest and Johannes (1995) dissected *Cryptomastix hendersoni* and found it anatomically similar to *Cryptomastix mullani*, so they placed it and all other species of *Cryptomastix*, except *Cryptomastix populi*, into the subgenus *Cryptomastix*. According to Article 70(b) of the Code (ICZN, 1985), the action by Webb (1970) should be reviewed by the International Commission on Zoological Nomenclature.

2. Reproductive Biology

For *Cryptomastix hendersoni* there seem to be no reports on potential longevity, generation time, the number and appearance of the eggs, or the situations used for oviposition. Captive maintenance of live snails, as was done for snails in other genera by Walton (1963, 1970), could provide an indication of potential longevity. Walton's results indicated that snails in the genus *Ashmunella* (also in the family Polygyridae but in a different subfamily) can live 8 or more years after reaching maturity. If *Cryptomastix hendersoni* has a potential life span of several years after reaching maturity, then individuals should have multiple opportunities to reproduce.

3. Ecology

Other than limited habitat observations, almost nothing is known about the ecology of *Cryptomastix hendersoni*. Snails in the family Polygyridae are all herbivorous, and this species will consume herbaceous plants in captivity (John Applegarth, personal observations). In the wild this species may also consume the decaying remains of herbaceous plants as well as algae from wet surfaces at the edge of streams and seeps. At low elevations sites near the Columbia River this snail may be negatively impacted by nonnative berry vines and trees because those plants can heavily shade sites and greatly reduce the native herbaceous vegetation on which populations of this snail may depend for food and shelter.

Specimens that appear to represent *Cryptomastix hendersoni* from the Mount Hood National Forest indicate that this species can also live on the damp floor of mid-elevation coniferous forests, away from the margins of streams, but in those situations they may have some dependency on a relatively closed forest canopy and an abundance of old woody debris for an adequately cool and damp microclimate.

C. Range, Known Sites

The type locality for *Cryptomastix hendersoni* is The Dalles, Wasco County, Oregon. With the exception of Rowland Spring (location #5 in Appendix A), which is roughly 8 km or 5 miles north of The Dalles, all of the other low elevation locations (sites near the Columbia River) are farther east. The eastern edge of the range of the Northern Spotted Owl crosses the Columbia River roughly 16 km (10 miles) northwest of The Dalles (USDA . . ., 1994b, page E-19), so those records (and all other records for "*Cryptomastix hendersoni*" in the Known Sites database) are for locations outside of the range of the Northern Spotted Owl. Specimens from the Blue Mountains and Hells Canyon areas that were identified to this species and included in the Known Sites database are now believed to represent other species according to Frest and Johannes (1995, 1996). The elimination of these records reduced the range of this species to the springs and spring-fed streams along both sides of the Columbia River from the vicinity of The Dalles east to the vicinity of Rufus, which are in parts of Wasco and Sherman counties in Oregon, and part of Klickitat County in Washington. That restricted range, represented by 13 known sites, was illustrated by a map in Hohler et al. (1997, Addendum page 180). The distribution of this species in the Columbia Basin was surveyed in detail during 1988-1992 by Frest and Johannes (1995), who reported that it is unlikely that either the number of sites or the known distribution of this species will be significantly expanded along the river.

Some snails recently found in the Mount Hood National Forest appear to represent this species and may represent a substantial extension of the known range of *Cryptomastix hendersoni*. The snails in question were found at four sites that are detailed in Appendix A (locations #14-17). The first two sites are close together in the Clackamas River Ranger District on the east side of Pup Creek (but not near the water) at about 1000 meters (3280 feet) elevation in section 19, T. 5 S, R. 6 E, Willamette Meridian. Later, more of these snails were found at two locations close together in the Hood River Ranger District at about 792 meters (2600 feet) elevation in section 25, T. 1 S, R. 10 E, Willamette Meridian, and roughly 1.6 km (1 mile) east of the Ranger Station. These new records suggest this species may have been distributed southwest of The Dalles along the old route of the Columbia River before it was blocked and forced north into its present route by the eruption of Mount Hood. This species now should be considered as known from the Clackamas River and Hood River Ranger districts and suspected in the Barlow and Zigzag Ranger districts. As yet there is no reason to expect this species within the Gifford Pinchot National Forest, but surveyors in the Mount Adams and Wind River Ranger districts ought to be able to recognize this species if they happen to encounter it while surveying for other mollusks.

Appendix A is an annotated list of the available records for this species.

D. Habitat Characteristics and Species Abundance

Along the Columbia River *Cryptomastix hendersoni* inhabits the margins of spring-fed streams and associated rock talus, including situations where there is perennial moisture under the surface of rock talus. This species survives the semiarid climatic conditions of the western part of the Columbia Basin by inhabiting the margins of spring-runs. These locations are at low elevation in the generally treeless and barren-looking landscape of the eastern part of the Columbia River Gorge. Elevation at the known sites ranges from 52 to 134 meters (170 to 440 feet) with an average of 78 meters (253 feet). Vegetation at known sites is either herbaceous in an open grassland, or there is an open canopy of riparian trees and bushes, but no conifers are reported as being either at the sites or immediately upslope. Herbaceous plants that have been noted include *Clematus*, *Mimulus*, *Rorippa*, and *Urtica*. Woody species include *Ailanthus* (an exotic tree), *Celtis*, *Cornus*, *Populus*, *Rhus*, and *Rosa*.

Where this snail has succeeded in surviving along the margins of spring-runs, there can be few to many individuals. Most of the museum collections are lots of 10 or more specimens. This species can be present in relatively dense populations (over 10 snails per square meter), but no quantitative studies on this species seem to have been conducted. The known populations may have been fragmented and restricted to spring-runs by climatic change but may have been further reduced by recent habitat loss. The small known total range of this species (taken in the restricted sense of Frest and Johannes, 1995, 1996), combined with the restriction to a few spring-fed streams within that range, makes this a rare species that can be locally abundant.

The recently discovered specimens from the Mount Hood National Forest appear to be *Cryptomastix hendersoni*, so this species is either ecologically plastic and is capable of living in a wide range of climatic conditions, or the montane populations may represent a distinct adaptation that could be a separate subspecies. Preliminary habitat notes indicate that none of the specimens were from the edge of streams. Instead most were in damp situations under relatively closed canopies in mature western hemlock forests that included some Douglas-fir, cedar, vine maple, and alder. The first ones found were under rotten logs that had been left at an old landing and are now overgrown by salmonberry and shaded by alder. Nearby surface vegetation included sword fern and Oregon oxalis. This site is on a gentle north-facing slope. The other three forest sites are generally similar to this one in terms of vegetation, aspect, and slope. Only one to three specimens per site were found, so the populations apparently are not dense.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage Standard and Guideline

The historical records (in the Known Sites database) for *Cryptomastix hendersoni* are outside of the range of the Northern Spotted Owl, and there is no indication that those low elevation populations associate with late-successional coniferous forests. The inclusion of this species in the Survey and Manage list (USDA . . ., 1994b, page C-59) may have resulted from an anticipation that this snail ranged farther west into the forested part of the Columbia River Gorge. However, new specimens from mid-elevations in the Mount Hood National Forest appear to represent this species. These new snails may prove to be indistinguishable from snails from the type locality, or they may represent a distinct race or closely related species. As noted above (in section IA), regardless of the taxonomic implications of future studies, this rare species now qualifies for management under the Survey and Manage standard and guideline.

B. Major Habitat and Viability Considerations

At the east end of the Columbia River Gorge most of the landscape is uninhabitable for *Cryptomastix hendersoni* because of aridity, so any dispersal would need to be along stream margins. However, most of the inhabited streams do not have perennial surface connections with other streams, so most of the known populations are presently isolated from one another and, therefore, more vulnerable to extirpation. However, land mollusks have low mobility and are relatively sedentary through geologic time. “If protected from catastrophes, snail colonies may not depend on immigration and could conceivably be self-sustaining for centuries -- in which case the distance to the next fragment [of suitable habitat] may not be very important” (Roth 1993). What is most urgent is the identification and conservation of the inhabited locations. “Even patches of a few hundred square meters could support 'reservoir' populations if appropriate habitat structures . . . were maintained” (Roth 1993).

The populations in the Mount Hood National Forest that appear to represent this species should have a better chance to survive on a long-term basis if detected and conserved through management. While there may be more connectivity within the mid-elevation forest habitat, the populations northeast and southwest of Mount Hood are separated by high-elevation terrain that this species probably cannot inhabit.

C. Threats to the Species

A threat to *Cryptomastix hendersoni* at all locations may be loss of reliable dampness.

For the mid-elevation populations in the Mount Hood National Forest that appear to be *Cryptomastix hendersoni*, any loss of woody debris and reduction of tree canopy could reduce the dampness available to the possibly isolated populations of this rare snail. Other threats could include activities that disturb or compact the soil, such as moving logs or driving vehicles within inhabited locations. The application or spilling of chemicals, including pesticides, herbicides, fertilizers, and firefighting chemicals could be harmful to populations of this snail. Nonnative plants and animals may be a threat and should be managed when a need is identified. Fire, both wild and planned, can directly kill these snails and degrade the quality of their habitat, but prescribed fire in adjacent areas could benefit this snail by reducing the threat from wildfire.

For the low elevation populations of *Cryptomastix hendersoni* that are in the semi-arid eastern part of the Columbia River Gorge, the two most apparent threats to the survival of this species are loss of perennial flow and habitat degradation. Loss of perennial flow can result from agricultural diversions and impoundments. Also, as more people live in this area, an increase in the number of water wells may decrease the output of springs. Habitat degradation can result from silt and toxic chemicals that enter these streams. Where roads and railroads cross these streams there is the risk of pollution by petrochemicals and herbicides. Another source of habitat degradation is domestic livestock that are allowed to graze within these spring-runs; both the mechanical impact of trampling and the vegetation alteration could contribute to extirpation of snail populations. An additional threat may come from quarrying operations (USDA . . ., 1994a, page 309). Although wildfire may be harmful to this species, as indicated by Frest and Johannes (1995), prescribed fire and manual removal of exotic brush and trees could benefit this snail by improving the growth of herbaceous vegetation.

D. Distribution Relative to Land Allocations

For the mid-elevation populations in Mount Hood National Forest that appear to be *Cryptomastix hendersoni*, observations for this species should be anticipated within all land allocations.

For the low elevation populations of *Cryptomastix hendersoni* that are in the semi-arid eastern part of the Columbia River Gorge, all known locations seem to be either on private land or road right-of-ways. None is within conifer forests managed by either Federal or State agencies. About half of the known locations are within the boundaries of the Columbia River Gorge National Scenic Area, but much of the land within that Scenic Area seems to be private, and any Federal lands are still outside of the range of the Northern Spotted Owl and not guided by the Forest Plan (USDA . . ., 1994b).

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The goal for management of *Cryptomastix hendersoni* is to assist in maintaining the viability of known and newly discovered populations of this species.

B. Specific Objectives

The specific objectives for *Cryptomastix hendersoni* are to identify and manage inhabited locations, maintaining the ecological framework in which this species can function as a natural component, so this species will have the opportunity to survive on a long-term basis. Specific objectives include:

- Maintain a locally favorable moisture regime (perennial flow of spring-runs in the Columbia River Gorge, and perennial dampness of the forest floor in the National Forest).

- Maintain uncompacted soil in and near populated areas.

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- Maintain or restore native herbaceous vegetation along streams in the Columbia River Gorge; maintain tree canopy, shrub and forb species and existing amounts of down woody material in the National Forest to provide cover and foraging substrates.

- Protect occupied sites from the negative effects of fire.

IV. HABITAT MANAGEMENT

A. Lessons from History

There seem to be no reports on populations of *Cryptomastix hendersoni*, or any other species in the genus *Cryptomastix*, that have been studied over a range of time or over a range of environmental conditions in such a way that inferences could be drawn concerning the environmental limitations and population responses of this species.

B. Identification of Habitat Areas for Management

At this time, it is suggested that all occupied known sites for this species be managed with a cautious approach. The word “site” refers to the defined point location where one or more shells and/or live snails of this species have been found. A point location can be the marked feature in a Sample Area (or Plot) where one or more examples were found, or the isolated site of a Point search, or the center of a group of sightings within 10 meters (33 feet) of each other and defined by UTM coordinates that are at least 10 meters from the next site. (10 meter intervals generally are the smallest units that can be reliably derived from a USGS topographic map when defining the UTM coordinates for a location.)

The Survey and Manage standard and guideline was designed for species that were thought to be rare, and *Cryptomastix hendersoni* seems to be a rare species. Therefore, the Habitat Area will be identified as the area around known site locations including all habitat features that contribute to environmental conditions important to the species at the known site. In most cases, this could be achieved by areas up to tens of acres (USDA . . ., 1994b, page C-5). As new data are compiled, consideration should be given to daily and annual movements within the life cycles of the organisms.

C. Management Within Habitat Areas

Within identified Habitat Areas at mid-elevations in the Mount Hood National Forest, management should make every effort to conserve the existing structural features and environmental conditions, including tree canopy, understory and herbaceous vegetation, woody debris of all decay classes, and any other factors that may be contributing to a relatively cool and damp microclimate on the forest floor. Occupied sites should be protected from introductions of nonnative species. This includes prohibiting use of un-washed vehicles that could carry weed seeds or other exotics, and use of hay bales or other nonnative mulching materials and planting mixes used for erosion control. As part of a protective approach to managing these Habitat Areas, there should be no activities that would substantially disturb or compact the soil (no yarding or vehicles), and there should be no management by means of fire or chemicals within the Habitat Areas that are identified for this species. This is a cautious approach that is recommended until the needs and abundance of this species are better understood.

At low elevation sites near the Columbia River, if there is ever an opportunity to manage Federal land (outside of the Northwest Forest Plan) to benefit a population of *Cryptomastix hendersoni*, then it is recommended that every action be taken to conserve the perennial nature of the surface dampness and the native composition of the local vegetation. Domestic livestock should be excluded. There should be no use or activities that remove water or release silt or toxic chemicals into these sites.

D. Other Management Issues and Considerations

In general, fire can be directly harmful to terrestrial mollusk populations. For the snails that appear to represent *Cryptomastix hendersoni* and have been found in the mid-elevation conifer forests of Mount Hood National Forest, fire may negatively impact identified Habitat Areas by degrading woody debris and reducing the tree canopy. On the other hand, reduction of hazardous fuels in adjacent areas that are not inhabited by this species ought to reduce the danger of a wildfire burning through an identified Habitat Area and, thereby, possibly causing a local extirpation.

For the isolated populations of *Cryptomastix hendersoni* along streams at low elevations near the Columbia River, negative effects of fire, in addition to direct mortality from the heat, are likely to include the temporary loss of native herbaceous plants that this species seems to need for food, cover, and microclimate. Frest and Johannes (1995) noted that major brush fires in 1994 had impacted some sites inhabited by this species. Fire may also have some positive benefits. If these snails survive the fire itself, then they may be favored by a reduction of blackberry vines and other exotic vegetation that can heavily shade sites and, thereby, reduce the supply of native herbaceous vegetation.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

Although the historic records in the Known Sites database for *Cryptomastix hendersoni* are all outside of the range of the Northern Spotted Owl, there is a possibility that this species occurs farther west along the Columbia River (in the forested parts of the Columbia River Gorge). Specimens that appear to represent this species from mid-elevations in the Mount Hood National Forest need further analysis to verify whether they represent this species, a distinct race of this species, or a closely related species.

B. Research Questions

What is the range of this species in the Mount Hood National Forest?
Does the air pollution in the Columbia River Gorge have any effect on this snail?
What are the threats to this snail from increasing recreational activities?
What anatomical differences distinguish this species from other *Cryptomastix*?
What external features can be used to identify this species in the field?
What habitat features are important for the local survival of this snail?
What are the life history, longevity, and reproductive ecology of this snail?
What are the daily and annual movements, and seasonally used structures?
How does this snail respond to prescribed fire and other vegetation management?

C. Monitoring Needs and Recommendations

Any newly discovered sites for *Cryptomastix hendersoni* on Federal lands under the Northwest Forest Plan should be monitored (1) to assess compliance with the Survey and Manage standard and guideline, (2) to evaluate the habitat impacts of management activities in and near these locations, and (3) to verify the continued existence of this species within each managed location. It is suggested that monitoring for presence be limited in frequency to minimize habitat disturbance and should be done when season and conditions are favorable for protocol surveys for terrestrial mollusks.

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APPENDIX A

Following is an annotated list of 17 locations for the Columbia Oregonian, *Cryptomastix hendersoni*, including four locations in the Mount Hood National Forest. In the Known Sites database (version 2.0) there are 64 records for this species, but most of those records have been subsequently rejected (Frest and Johannes, 1995, 1996). Location #1 is the type locality, and the rest are arranged by the first date they were visited. After the location number (and the record ID numbers from the Known Sites database) there is a brief description of the location, followed by the date(s) of collection and number of specimens (plus the museum acronym or name of specimen holders and their catalog numbers, if any). The annotation includes any corrections and questions, an estimate of the UTM coordinates, an estimate of the elevation, the name of the USGS 7½-minute topographic map, the land ownership, and the level of precision code (plus the original code if it seems incorrect). In the Known Sites database all records were graded on apparent precision of the location description. Precision codes are S = second record (accurate to ± 45 m or 150 feet), M = minute record (accurate to ± 2.4 km or 1.5 miles), G = general record (accurate to ± 8 km or 5 miles), and V = vague record (cannot be located within ± 8 km or 5 miles). Mappable locations are hereby defined as those with precision = M or S.

#1 (90101733, 90101734, 90101739, 95200027-95200028, 95200035-95200036, 95200058, 95400031) **Type locality** — Oregon, Wasco County, **The Dalles**. There are 84 or more specimens (ANSP 11108, 145479, 398358; and CAS 47531, 49747-8, 49750, 49752) that were collected by Henry Hemphill (who lived 1830-1914) but no collection dates are recorded. This location has been described as "near The Dalles" (Pilsbry, 1928; CAS 47531) and "The Dalles" (Pilsbry, 1940; the remaining museum specimens). This material could be a composite of collections from both in and near (probably within 5 miles of) The Dalles and made on one or several dates, possibly over a period of years. Elevation range within The Dalles (before the dams) was about 12-122 m (40-400 ft); USGS map = The Dalles South, OR-WA, 1977; land within 5 miles is all privately owned; and precision = G (not S or M).

#2 (95200034) Oregon, Wasco County, The Dalles, **Threemile Creek**. Collected by Henry Hemphill (who lived 1830-1914). 16 specimens (CAS 49749). Threemile Creek is *near* The Dalles (there is a possibility that all of Hemphill's specimens came from Threemile Creek, including the type specimen). Early roads such as the Old Dufer Road may have provided access to upstream areas. USGS map = The Dalles South, OR-WA, 1977; except for 40-acres of BLM land on Dry Fork, all land along Threemile Creek is private; precision = G (not M).

#3 (95300017) Oregon, Wasco County, **"Dalles East 2"** — northwest side of Signal Hill by Interstate Highway 84, seepy base of basalt cliff on southeast side of east-bound lanes, in SW/4 of NE/4 of NW/4 of section 29, T. 2 N, R. 14 E. 1989 January 11, March 19, and November 18. Locally abundant (Deixis locality 330). UTM are about 648220 E and 5054610 N; elevation is about 67 m (220 ft); USGS map = Stacker Butte, WA-OR, 1974; land ownership may be highway right-of-way or private; and precision = S.

#4 (95300053) Oregon, Wasco County, **"Eightmile Creek 2"** — roadside seeps at 2.3 road miles up Lower Eightmile Road (former US 197) from road junction at mouth of Eightmile Creek, short southwest-facing basalt cliff in SE/4 of SE/4 of SE/4 of NE/4 of section 9, T. 1 N, R. 14 E. 1989 March 18, and November 13. Locally rare (Deixis locality 595). UTM are about 651910 E and 5049490 N; elevation is about 122 m (400 ft); USGS map = Petersburg, OR-WA, 1978; land ownership may be private or road right-of-way; and precision = S.

#5 (95300025, 98100012) Washington, Klickitat County, **"Rowland Spring" —** actually a spring-fed stream 1.6 km (1.0 mile) SSE of Rowland Spring, upslope side of state route 14, SE/4 of NW/4 of NW/4 of SW/4 of SE/4 of section 8, T. 2 N, R. 13 E. 1989 March 20, and 1996 May 30. Locally uncommon (Deixis locality 341, Applegarth locality 122). UTM are 639760 E and 5058610 N, elevation is about 52 m (170 ft); USGS map = The Dalles North, OR-WA, 1974; land is highway right-of-way or private; and precision = S.

#6 (90088637) Oregon, Wasco County, **"4.7 miles east of The Dalles Dam,"** roadcut on south side of Interstate 84, SW/4 to NE/4 within NE/4 of NW/4 of section 29, T. 2 N, R. 14 E. 1989 November 18. 15 specimens (ANSP-A16776). Inconsistent location descriptions — 4.7 miles *east* of interchange at Oregon end of The Dalles Dam is in NW/4 of NE/4 of section 23 on north side of Kaser Ridge; 4.7 road miles *west* of the NE/4 of NW/4 of section 29 is adjacent to The Dalles (town) but not near reference point; and in section 29 the center of the defined area, which is 0.5 km long, is 4.7 *km* (a coincidence?) east of the interchange for The Dalles Bridge and 1.15 road miles NE of the interchange overpass at Oregon end of The Dalles Dam, so there is a discrepancy of 5.7 km (3.5 miles). USGS map = Stacker Butte, WA-OR, 1974; land ownership may be private or highway right-of-way; and precision = G (not S).

#7 (95300031) Oregon, Wasco County, **"Eightmile Creek 8"** — roadside seeps at 2.9 road miles up Lower Eightmile Road (former US route 197) from road junction at the mouth of Eightmile Creek, short southwest-facing basalt cliff, SW/4 of SW/4 of SW/4 of NE/4 of SW/4 of section 10, T. 1 N, R. 14 E. 1990 March 24. Locally rare (Deixis locality 360). Road miles comes closer to center of W/4 of SE/4 of SW/4, so there discrepancy of roughly 213 m (700 ft) between location descriptions. Mouth of stream (between locations) has approximate UTM of 651600 E and 5049000 N; elevation is roughly 134 m (440 ft); USGS map = Petersburg, OR-WA, 1978; land is private or road right-of-way; and precision = M (not S).

#8 (95300039) Oregon, Sherman County, **first spring west of Rufus**, spring-fed stream on steep, basalt talus slope in SW/4 of SE/4 of SE/4 of NE/4 of SE/4 of section 2, T. 2 N, R. 16 E. 1990 March 25. Locally common (Deixis locality 404). UTM are roughly 673600 E and 5061000 N; elevation range is 61-122 m (200-400 ft); USGS map = Biggs Junction, OR-WA, 1977; land ownership appears to be private; and precision = S.

#9 (95200135-95200136, 95200145, 95300042) Washington, Klickitat County, **first spring west of Sam Hill Bridge**, 1.0 road mile WSW of north end of Sam Hill Memorial Bridge (US route 97), and roughly 610 m (2000 ft) east of Maryhill Museum, streams and rocks in ditch between unpaved road and railroad grade in SW/4 of NW/4 of SE/4 of NE/4 of NW/4 of section 7, T. 2 N, R. 16 E. 1990 April 22-23, and 1991 June 15. 18 or more specimens (SBMNH unnumberd, Deixis locality 406). UTM are about 667000 E and 5060200 N; elevation is about 55 m (180 ft); USGS map = Biggs Junction, OR-WA, 1977; land (ditch and adjacent road) may belong to railroad; and precision = S (not M).

#10 (95300023) Oregon, Wasco County, **"Celilo West 1"** — south side of Interstate 84 (US 30) about 1 mile west of Celilo Village, 0.2 mile SW of railroad drawbridge, and in north half of NE/4 of SW/4 of SE/4 of NE/4 of section 19, T. 2 N, R. 15 E. 1990 April 23. Locally abundant (Deixis locality 340). A "somewhat seepy" rock pile "somewhat shaded" by trees (*Populus* and *Ailanthus*) and adjacent to high basalt cliff. UTM are about 657300 E and 5056200 N; elevation is about 70 m (230 ft); USGS map = Wishram, WA-OR, 1977; land ownership could be private or highway right-of-way; and precision = S.

#11 (95200134) Oregon, Wasco County, **"Dalles East 3"** — springs and talus at 0.25 mile NE of Oregon end of The Dalles Dam, in SE/4 of section 30, T. 2 N, R. 14 E. 1990 April 23. One specimen (SBMNH unnumbered). On 1996 May 30 the survey-and-manage mollusk subgroup, guided by Terrence Frest and Edward Johannes, collected snails at this location but did not find this species. The location with the SBMNH specimen is "center of NE/4 of SE/4 of NE/4 of SE/4 of section 30 " but location visited by subgroup in 1996 is closer to center of NE/4 of NW/4 of SE/4 of SE/4 of section 30 (latter is presumed correct). UTM are about 647560 E and 5053720 N; elevation is about 76 m (250 ft); USGS map = Petersburg, OR-WA, 1978; land could be either private or highway right-of-way; and precision = S.

#12 (95300021) Washington, Klickitat County, **"Wishram East 2"** — open basalt talus below (SE of) Burlington Northern railroad track in NE/4 of NE/4 of NE/4 of NE/4 of SE/4 of section 15, T. 2 N, R. 15 E, and 1.1 miles SW of mouth of Hells Gate Canyon. 1990 May 27. Locally common (Deixis locality 335). Vegetation included *Clematus*, clumps of *Urtica*, and a few *Celtis* and *Ailanthus*. There is discrepancy of 0.27 km (0.17 mile) between the TRS and mileage from mouth of Hells Gate Canyon. If TRS is correct then UTM are about 663230 E and 5057980 N; elevation is about 52 m (170 ft); USGS map = Wishram, WA-OR, 1997; land could be private (railroad) or Federal (US Army Corps of Engineers); but until discrepancy is resolved the precision = M (not S).

#13 (95300022) Washington, Klickitat County, **"Wishram East 3"** — seepy basalt talus and cliff on NW side of Burlington Northern railroad track in NW/4 of SW/4 of SW/4 of SW/4 of NW/4 of section 14, T. 2 N, R. 15 E, and about 0.9 mile SW of mouth of Hells Gate Canyon. 1990 May 27. Locally abundant (Deixis locality 336). Vegetation included "a fair amount of" *Clematus*, *Urtica*, *Rhus*, and sparse *Artemisia*.

UTM are about 663290 E and 5058080 N; elevation is about 61-73 m (200-240 ft); USGS map = Wishram, WA-OR, 1997; land is probably private (railroad right-of-way); and precision = S.

#14 (not in Known Sites database) Oregon, Clackamas County, Mount Hood National Forest, Clackamas River Ranger District, **old log landing east of road 5412** (about 30 m or 100 ft east) and 0.35 mile north of spur 120, mid-slope bench east of Pup Creek, NW/4 of SW/4 of NE/4 of section 19, T. 5 S, R. 6 E. 1998 October 20. 1 adult shell (sent to Thomas Burke). Estimated UTM are about 569300 E and 4996960 N (per marked copy of aerial photo); elevation is about 997 m (3270 ft); USGS map = Fish Creek Mountain, Oregon, 1985; land is Federal (Mount Hood National Forest); and precision = S.

#15 (not in Known Sites database) Oregon, Clackamas County, Mount Hood National Forest, Clackamas River Ranger District, **forest floor north of spur 120** (about 60 m or 200 ft north) and east of road 5412, mid-slope bench east of Pup Creek, NW/4 of SE/4 of NE/4 of section 19, T. 5 S, R. 6 E. 1998 October 20. 3 live snails (sent to Thomas Burke). Estimated UTM are about 569720 E and 4996930 N (per marked copy of aerial photo); elevation is about 1000 m (3280 ft); USGS map = Fish Creek Mountain, Oregon, 1985; land ownership is Federal (Mount Hood National Forest); and precision = S.

#16 (not in Known Sites database) Oregon, Hood River County, Mount Hood National Forest, Hood River Ranger District, roughly 1.6 km (1 mile) east of the Ranger Station, NW/4 of **SW/4 of section 25**, T. 1 S, R. 10 E. 1998 November 10. One shell (retained). Mid-mature forest (western hemlock and vine maple) with 85% canopy closure. Stated UTM are 613468 E and 5043940 N; stated elevation is 792 m (2600 ft); USGS map = Parkdale, OR, 1994; land is Federal (Mount Hood National Forest); and precision = S.

#17 (not in Known Sites database) Oregon, Hood River County, Mount Hood National Forest, Hood River Ranger District, roughly 1.6 km (1 mile) east of the Ranger Station, SW/4 of **NW/4 of section 25**, T. 1 S, R. 10 E. 1998 November 10. Two juvenile snails (observed by Sara Carlsen but not collected). Stated UTM are 613474 E and 5044082 N; stated elevation is 792 m (2600 ft); USGS map = Parkdale, OR, 1994; land ownership is Federal (Mount Hood National Forest); and precision = S.

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SECTION NO. 3
Deroceras hesperium
Evening Fieldslug

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Management Recommendations
for
Deroceras hesperium, Evening fieldslug

V. 2.0

by

Thomas E. Burke

Wenatchee National Forest
Entiat Ranger District

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EXECUTIVE SUMMARY

Species: *Deroceras hesperium*, Evening fieldslug

Taxonomic Group: Mollusks (Phylum Mollusca: Class Gastropoda)
Family: Limacidae

Other Management Status: *Deroceras hesperium* is on the Oregon Natural Heritage Program (ONHP) list 1, the Washington State Monitor list (WM). It is a BLM tracking species (BLMT) in Washington and a BLM sensitive species (BLMS) in Oregon.

Range: Low to mid elevations in the western Cascade Range to the Pacific Ocean and from northwestern Oregon through western Washington and onto Vancouver Island, B.C. No currently extant known sites are known.

Specific Habitat: Habitat is largely unknown but, based on limited information, includes varied low vegetation, litter, and debris; rocks may also be used.

Threats: Primary threats to this species are habitat destruction from forest management, conversion for agricultural, urbanization and other uses, and fire. Natural threats may include vertebrate and invertebrate predators (i.e., predatory snails and beetles), especially in locally restricted areas.

Additional concern is warranted for very rare species for which extirpation at one site may result in species extinction. The last report of living *Deroceras hesperium* was in 1969 (Branson 1977). It has been known from a few scattered sites within a fairly broad range. Based on what is currently known, its status is not at all secure. While it may logically be expected to still occur in the Columbia Gorge east of Portland, on the north slope of the Olympic Peninsula, and at other sites in western Washington and Oregon, that is merely speculation, since there are no recent records of it.

Management Recommendations:

- Protect the existing occupied sites from activities that would alter microsite characteristics, including areas large enough to moderate fluctuations in humidity and temperature, and to protect other environmental characteristics.

- Protect cover by preserving dead and downed woody debris. Within habitats for these species a greater abundance of large woody debris will be necessary than that prescribed in the ROD; the quantity needed is yet to be determined (ROD pg. C-40, item A).

- Protect occupied rockslides and talus areas from road construction, quarrying, and other activities.

- Maintain natural canopy closure of trees within the habitat area to moderate fluctuations of temperature and humidity on the site.

- Maintain the hardwood tree component (i.e., maples, cottonwood, red alder, aspen) and native plant diversity to provide a constant supply of logs, leaves, and leaf mold.

- Protect known occupied riparian sites by maintaining riparian areas according to ROD guidance (pgs. C30-C38) and, if necessary, increasing Riparian Reserve widths.

- Protect known occupied sites from adverse effects of fire.

- Protect Habitat Areas from activities that would significantly compact the soil or disturb the litter layer.

Information Needs:

What is the specific range of each of these species?

What is the range of habitat conditions tolerated by each species and the specific biological and physical attributes of the habitat:
- Plant associations;
- Specific plant species required/used;
- Specific foods;
- Amount of large woody debris desired;
- Optimum forest crown cover to maintain desired conditions;
- Other stand structure and components
- Soil types, geology;
- Temperature, humidity.

What are the stand characteristics (canopy cover, age, large woody debris, litter, and duff, etc.) required to support the conditions required?

How do the required stand characteristics vary under different circumstances (elevation, slope, aspect, etc.)?

What stand size is required to provide sufficient area of suitable habitat for viable populations?

How long is required for recolonization of a site by individuals from adjacent populations?

Monitoring of known sites is needed to:
- track trends in populations (numbers, density, and distribution), reproduction, quantity, and quality of habitats;

- determine impacts on habitats and populations from management activities, natural disturbances, and vegetative succession;
- maintain a database to document trends in populations and habitats.

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I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Family: Limacidae

Deroceras hesperium Pilsbry, 1944

Generic history includes: *Chorolimax* Westerlund, 1894; *Hydrolimax* Malm, 1868; *Agriolimax* Morch, 1865; *Malino* Gray, 1855; *Krynickillus* Kaleniczenko, 1851; *Krynickia* Kaleniczenko, 1839; and *Deroceras* Rafinesque, 1820. Although Agriolimax had been in universal use, it was preceded by several earlier names, *Deroceras* taking precedence by being the earliest (Pilsbry 1948).

B. Species Description

1. Morphology

Pilsbry (1948) provided the following descriptions and comments from observations of preserved specimens:

… the back is rounded except close to the end, where the tail is very shortly carinate above. Mantle brown with small scattered light spots. The back elsewhere rather light with some faint brown spots; flanks light, paler below the mantle. Sole tripartite, the areas of equal width, the middle one a shade darker than the sides. Length 16 mm.

This is certainly a distinct species, most easily recognized by the enlarged duct of the spermatheca, which may be seen quite easily on opening the anterior end of the animal, without further dissection.…

Similar species include *D. laeve* which is found throughout North America from the Arctic to Central America, and *D. monentolophus* which has been recorded from southern California and Seattle.

D. laeve is: "… usually various shades of amber, without spots or markings, sometimes blackish; head and tentacles smoky. Body cylindrical, … terminating in a very short carina at its posterior extremity.… Back covered with prominent elongated tubercles and furrows. Foot narrow, whitish.… Length about 1 inch (Binney, 1842, in Pilsbry, 1948).

D. monentolophus is similar to *D. laeve*: The mantle is closely speckled with black or very dark brown, and there is more or less marking on the circular area around the pneumostome. Back behind the mantle also closely but somewhat less intensely marked with black, the markings disappearing towards the foot and anteriorly. The pedal margin is more or less speckled with gray. Top of the head and tentacles dark. Length (as preserved) 21 mm (Pilsbry, 1948).

The shells of these three species are unique as described and illustrated in Pilsbry (1948): *D. hesperium* - "Shell thin, somewhat squarish, the nucleus terminal but a trifle to the left of middle, the posterior outline convex on the left of it, straightly sloping to the right. Lateral margins straight and parallel. Anterior margin broadly arcuate. It is a little convex along the left third of the width; the surface marked with close but extremely slight growth lines. Interior concave. Length 3.3 mm." The shell appears somewhat rectangular, the sides nearly parallel, the front slightly rounded, the rear quite so. The growth lines follow the shape of the shell, but are quite oval in the early stages.

D. laeve - about 4 mm long; oblong, the nucleus not quite terminal on the left side of the posterior end. It is elongated with nearly parallel sides, round anteriorly, somewhat pointed posteriorly. Growth lines approximate the shell shape, growth apparently from the left rear corner to the right front.

D. monentolophus - about 4.5 mm long; oblong with terminal apex and parallel sides. Rather deeply rounded in front; the posterior end a little truncate, and sloping at the sides. It appears slightly curved, the left side slightly convex, the right side concave. Growth lines oblique across the older half of the shell, appearing that there is a torsion to the right during growth.

Branson (1977) reported 3 specimens from the northern side of the Olympic Peninsula that he believed to be this species. He described them as "… light brownish with scattered light spots, and the pneumostome is surrounded by a pigmentless halo. Measurements: 18.7 mm (range 17.5-20.0 mm) in length, foot width 3.3 mm (range 2.8-3.8 mm), and 5.8 mm (range 5.0-6.5 mm) from anterior tip of mantle to anterior edge of breathing pore."

2. Reproductive Biology

Nearly all of the terrestrial gastropods in the Pacific Northwest, including *Deroceras*, are hermaphroditic, having both male and female organs. Self fertilization has been demonstrated in some species, although cross fertilization is probably the norm. Bayne (1973) discussed problems encountered with self and cross fertilization in Pulmonates, and the dominance of allosperms (sperm from another) over autosperms (sperm from oneself). Slugs, such as *Deroceras* are oviparous (egg laying).

3. Ecology

Deroceras hesperium is one of the least know slugs in the Western United States. Nothing specific could be found on the ecology of the species other than a broad description of the habitat in which it was found. Branson (1977) found it in low elevation, moist conifer forests with a hardwood tree and shrub component. For details, see Habitat Characteristics, below.

C. Range, Known Sites

The historic range of *D. hesperium* is northwestern Oregon through Western Washington, to Vancouver Island, British Columbia, Canada. Pilsbry (1948) said, "It is to be expected throughout the humid coastal region of the northwest."

This slug has been reported from only 7 locations in three general areas, northwestern Oregon, the northern Olympic Peninsula, and the northeast coast of Vancouver Island. The type locality is Oswego, Clackamas Co., OR. It has also been reported from Portland, Multnomah Co., and 11 miles east, Hood River, Wasco Co., OR., and from Comox, B.C. on the northeast coast of Vancouver Is., 140 miles north of Victoria, B.C. (Pilsbry, 1948). Branson (1977) reported it from 2 locations on the northern Olympic Peninsula, Clallam Co., WA.

D. Habitat Characteristics and Species Abundance

D-1. Habitat Characteristics - Branson (1977) found two slugs of this species in hemlock, grand fir, maples, ferns and mosses at 610 meters (2000 feet) elevation, and one among hemlock, black cottonwood, spruce and salmon berry at 8 meters (26 feet) above sea level. In general, gastropods are found under rocks or logs and among talus, litter, debris, and ground vegetation, and these microsites should be considered the places in which to expect this species. *Deroceras hesperium* is apparently also found in quite moist sites and may be associated with riparian habitats, although there is no evidence that it is a riparian obligate.

D-2. Species abundance - Pilsbry (1948) referred to many specimens opened by him, and at least multiple specimens from each locality, but all "collected over 50 years ago...." However, Branson (1977) found only three specimens in his surveys of the Olympic Mountains and none in his surveys of the Washington Cascades (Branson, 1980) or Oregon Cascades and Coast Ranges (Branson and Branson, 1984). This is one of the least known slugs in the western United States.

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II. CURRENT SPECIES SITUATION

A. Why Species is Listed Under Survey and Manage Standards and Guidelines

Findings under the FEMAT assessment implied that, under the preferred alternative, without survey and manage standards and guidelines, *Deroceras hesperium* had a 30% chance of being well distributed across Federal lands, a 30% chance of being locally restricted (i.e., with significant gaps between populations), a 20% chance of being restricted to refugia, and 20% of being extirpated. Based on current knowledge there are significant gaps between populations. Until we locate some existing populations, there is no basis to assume that this condition would improve. Without survey and manage, there would be a greater likelihood that they would be confined to refugia provided by LSR's and/or congressionally withdrawn areas or extirpated, than that their status would improve. If surviving populations are discovered, as seems likely, the probability of a more favorable outcome might increase. Without survey and manage, the liklihood of that happening appears remote.

USDA, Forest Service, and Department of Interior, Bureau of Land Management (1994: J2-345) "Summary" states, "The rating reflects uncertainty about the number of species locations that would be protected by riparian reserves or LSRs under the proposed action or any other alternative. Given this uncertainty, there is some likelihood that the species may be extirpated from some parts of its range."

B. Major Habitat and Viability Considerations

Current information, or lack thereof, indicates that this is truly a rare species. Although, the areas in which it should be expected have been surveyed (lightly), *D. hesperium* has been found poorly represented relative to other gastropods. The status of the 4 known sites that occurred in the Portland area are unknown. Discussion in Appendix J2 seems to speculate that the species still occurs in many more areas than have been confirmed. Although this assumption is reasonable, that conclusion should not be made until surviving populations have been found.

C. Threats to the Species

Current knowledge implies that *Deroceras hesperium* is a rare slug. The condition of the habitats at the sites from which it has been found is uncertain. A major concern would be loss of occupied habitat from human activities. Exact locations of the known sites are uncertain, so inadvertent destruction of these habitats and any currently unknown populations, before they are discovered and their requirements determined, is a highly potential risk.

D. Distribution Relative to Land Allocations

One of the sites from which *D. hesperium* is known is near a campground in Olympic National Park. Another of the sites is on the Makah Indian Reservation. The current situation of four locations that occurred in the Portland area is unknown. The seventh location is in Canada.

III. MANAGEMENT GOALS AND OBJECTIVES

The following management goals and objectives apply to all species discussed in this document.

- **Management Goals for the Taxon**

  Management goals for these species are to assist in maintaining the species viability.

  This will require that we maintain the species across their existing ranges by avoiding actions that would adversely impact existing populations or degrade their occupied habitats to a quantity and/or quality below the threshold needed to maintain species persistence.

- **Specific Objectives**

  At this time, protection of existing occupied habitats should be the priority for management. Manipulation of these habitats should not be attempted until the needs of each species of concern occupying the site, and ecosystem dynamics of the site have been evaluated. Manipulation of habitat on some sites might be desirable in some few cases, but this is not intended to say that management will always be necessary. Specific objectives include:

  - Protect existing occupied sites from activities that would alter microsite characteristics, including areas large enough to moderate fluctuations in humidity, temperature, and other environmental characteristics.

  - Identify and maintain potential refugia for the species such as down wood, exposed roots, litter, rocks, and debris piles.

  - Maintain native plant communities around known site locations, including a diversity of tree, shrub, and ground cover species to provide shade, food sources, and substrates for fungi.

  - Maintain uncompacted soil and undisturbed forest floor litter.

IV. HABITAT MANAGEMENT

A. Lessons from History

If we have learned anything from history, it should be that managment with a single or primary objective, creates more problems than it resolves. Therefore, when managing habitat for a survey and manage species, other species, other resource objectives, and the ecosystem as a whole, including natural succession, potential natural disturbances within the site, and influences from adjacent lands, should all be considered.

Once extirpated from a site, populations of most gastropods are slow to recover. Fire is very destructive to snails and slugs, not only killing them outright, but in its destruction of logs and other woody debris which hold moisture and create microsites necessary for survival of these animals (Applegarth, 1995; Burke, personal observations). Sites that appear to be suitable habitat for many gastropods, but which have been burned in the past, support few if any species or individuals even after 50 years and longer. Some of the more abundant, larger species begin repopulating these sites from adjacent stands after suitable habitat for them is restored, which may take many years. The first species to reappear in western Washington stands are usually the *Haplotrema* and *Vepericola* (Burke, personal observations). These species are the most abundant of the large snails in a variety of forest habitats. The time required for the abundance and diversity of the molluscan fauna to be restored to these sites is indicated by the much greater numbers of species and individuals found in old-growth than in stands in which signs of fire (and other management in some cases) are still evident--not necessarily obvious. In these burned stands, we have an ecosystem which is lacking the components and functions provided by the mollusk fauna.

In contrast to severely burned areas, stands in which numerous large logs were left and which were not severly chared during the fire have been found to retain a portion of their mollusk fauna after an undetermined number of years but within a time that evidence of the burn was still apparent upon examination of the site. Logs were not measured, but are estimated to be well over 1000 linear feet per acre, and greater than 20 inches average diameter. Whether these gastropods remained through the burn, protected by the abundant logs, or they were able to more rapidly disperse back into the stand because of the cover provided by the logs has not been determined. What is apparent is that an abundance of large logs is important to many forest snails and slugs. Zero to two or rarely three species may be expected in burned stands without abundant logs remaining; five to seven species may be expected to be found in stands similarly treated but with the logs remaining; and in unburned stands 13 to 20 or more species may be found (Burke, unpublished report). Therefore, it is apparent that an intense burn leaves the biotic community under moist conifer stands with only a small fraction of its molluscan fauna for many years (possibly a century or more). Fire is generally not acceptable management for the habitat of these species.

B. Identification of Habitat Areas for Management

As of August 1998, it is considered important to protect all known occupied sites for this species on public lands due to their rarity. The Habitat Area will be identified as the area around known site locations which includes all habitat features that contribute to environmental conditions important to the species at the known site. In most cases, this could be achieved by areas up to tens of acres (ROD C-5). For species which are known to be extremely rare, as this one seems to be, larger areas may be considered in order to fully account for the unknown variables in habitat that may limit the suitability of the area for the species. As new data is compiled, consideration should be given to daily and annual movements within the life cycles of the organisms.

C. Management Within Habitat Areas

This species is quite vulnerable to heat and desiccation and uses logs and other large woody debris, forest floor litter and spaces under or between rocks as refugia - areas that maintain low temperature and moderate to high humidity. Management considerations should focus on maintaining the temperature and moisture regime of these microsites. This requires that overstory crown cover and understory vegetation be retained to shade the ground, povide humidity through evapotranspiration, condense fog and dew, intercept underground water and hold it on the site, and impede air movement that would tend to displace the cool moist air. Available crown cover information for these habitats is meager, but observations recorded in some western hemlock/Douglas-fir stands indicated summer crown cover of 70%-90% plus.

Care should be taken to maintain or enhance the naturally occurring diversity of plant species in Habitat Areas. This will increase the range of hosts for a variety of species of fungi and make other food substrates available throughout the season. It will also provide insurance that specific plant species, if found to be critical in the life cycle of these mollusk species, are not inadvertently lost. As yet we know too little about the needs of this species to identify an optimum mix of tree species, but it appears that mixed stands of conifer and hardwoods provide the best habitat. Certainly, maintaining a mix such as occurs in natural late successional stands, would provide a more diverse and complete set of conditions for multiple species and a more fully functioning ecosystem.

Management also requires maintenance and future recruitment of large and small woody debris, and a thick layer of litter and duff on the forest floor. These components provide cool moist places in which these animals spend the days, hide from predators, deposit their eggs, and find food. These animals use a wide variety of sizes of large woody debris. Logs appear to provide dispersal corridors as well as the above mentioned essential habitat elements. Habitat quality probably improves in direct proportion to the amount of large woody debris to a point where the debris interferes with the shade and humidity regulating function of the forest canopy cover.

All Habitat Areas should be protected from fire events which cause direct mortality and loss of habitat. Prescribed fire treatments may be used to reduce fuel loading outside of Habitat Areas to protect those areas from catastrophic wildfire events.

Activities which cause soil compaction or disturbance to forest floor litter should be prohibited within designated Habitat Areas.

Protect occupied rockslides and talus areas from road construction, quarrying, and other major site disturbing activities that may cause temperature and/or humidity changes within the interspaces. These sites should be considered potential habitat when they lie within or near to suitable moist forest habtat areas, or at the edges of moist or wet mountain meadows.

Protect or manage occupied riparian sites as for other ocupied sites, but consider increasing the width of occupied riparian reserves as part of management for these mollusk species.

Mollusk species are known to have limited dispersal abilities and the current species diversity is the result of generations of isolated populations developing unique characteristics. Care should be taken not to further isolate individual populations. Therefore, in addition to managing this species group within designated management areas, attempts should be made to connect these management areas to each other or to other reserves such as riparian reserves and LSR's; either directly, by locating them adjacent to occupied habitat within reserves, or indirectly, by retaining suitable quantities of key habitat elements in harvest or project areas to provide a potential bridge or temporary "bank account" to accelerate future habitat development.

Historic sites need to be relocated and occupancy confirmed since the older known sites were located from museum records which may be 50 or 100 years old. Since site locations may not be accurately described, or habitats may have been modified over the years, adjacent sites that appear to be suitable habitat should also be searched for the species.

D. Other Management Issues and Considerations

At the time of the FEMAT Analysis this species was known from few sites and few had even been seen by living malacologists. Much of the habitat from which they had previously been known, had been developed into urban or agricultural areas, or entensively managed.

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Deroceras hesperium is a species needing much more careful study. Because it is known from very few sites, disturbance to occupied habitats for surveys or monitoring should be limited to no more than 5% of the area or be strictly regulated to prevent inadvertent extirpation by researchers and other curious people.

V. RESEARCH, INVENTORY AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

What is known of the habitat and ecology of this species is from few, generally poorly documented observations. That it is found in generally undisturbed moist forests can be pieced together from the available descriptions of the locations in which it has been found. Literature sources (Pilsbry, 1948; Branson 1977, 1980; Branson and Branson, 1984; Frest and Johannes, 1993, 1996)give general site information at best, but detailed records of specific plants or other micro-habitat elements are primarily from personal knowledge (Frest, personal communications; Burke, personal observations). Although, we can recognize some potential environments, we have too few observations to understand the full range of habitats or the ecological relationships of these animals.

Only a few of the land allocations of the known sites were available at this writing. Others need to be determined and recorded.

B. Research Questions

What is the specific range of this species?
What is the range of habitat conditions tolerated by the species?
What is the range of conditions required for populations to remain secure and viable?

Biological attributes:

! Plant associations;
! Specific plant species required/used;
! Specific foods;
! Amount of large woody debris desired;
! Optimum forest crown cover to maintain desired conditions;

- Other stand structure and components (e.g., small woody debris, litter, duff, water, etc.)?

Physical attributes:

- Elevation;
- Soil types, geology, trace elements;
- Temperature, humidity.

What are the stand characteristics (canopy cover, age, large woody debris, litter and duff, etc.) required to support the conditions required?

How do the required stand characteristics vary under different circumstances (elevation, slope, aspect, etc.)?

What stand size is required to provide sufficient area of suitable habitat?

How long is required for recolonization of a site from adjacent populations?

What are the effects of herbicides and other chemicals used in forest management on mollusk species.

C. Monitoring Needs and Recommendations

Monitoring of known sites is recommended to track trends in populations (numbers, size and density), reproduction, quantity and quality of habitats.

Monitoring is also recommended to determine impacts on habitats and populations from management activities, natural disturbances, and vegetative succession. Monitoring should include:

- Conduct surveys in spring and fall after the first heavy rainfall or frost.

- Record all environmental conditions where these species are found to better understand their habitats and management needs.

- Through surveys and studies, determine the extent of the species range, and the habitats and ecology of the species.

- Monitor sites for conditions and trends of populations.

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SECTION NO. 4

Helminthoglypta hertlieni

Oregon Shoulderband

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Draft Management Recommendations
for
Helminthoglypta hertlieni, the Oregon Shoulderband

Version 2.0

by

Ted R. Weasma

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EXECUTIVE SUMMARY

Species: *Helminthoglypta hertleini* Hanna & Smith (Oregon Shoulderband)

Taxonomic Group: Mollusks (Phylum Mollusca); Snail (Class Gastropoda); Land Snail (Order Pulmonata)

ROD Components: Survey and Manage Strategy 1 & 2

Other Management Status: An Oregon Natural Heritage Program List 1 species (critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation, typically with 5 or fewer occurrences).

Range: The species is rare and known from a total of 16 sites. The **Type Locality** is along Route 66 east of Ashland, Oregon. It is known from the Klamath Province, including Jackson County, Oregon, on BLM Medford District, and Siskiyou County, California, with Shasta River sites on or adjacent to BLM land and near the eastern border of the Klamath National Forest. The species is expected to be found as far north as Douglas County, Oregon.

Specific Habitat: The species is found in basalt rockslides (talus), under rocks and woody debris in moist conifer forests, and in shrubby areas in riparian corridors. No strong riparian association has been identified.

Threats: Given that little information is available about the habitat needs of the species, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities which increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means (including fire, herbicide use, recreation development, quarry development, road construction, and major maintenance), over-collecting and disturbance during aestivation may constitute major threats to this species.

Management Recommendations: In general, manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Adjacent forested areas should be managed to provide shade, coarse woody debris, and uncompacted forest litter. Due to the rarity of known populations, sites should be protected from wildfire events.

Information Needs: Information is needed on the actual range of the species, the location of other populations, the stability of the known populations, and the factors that control population stability.

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I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Helminthoglypta was first described by Ancey in 1887 (June) in The Conchologist's Exchange, 1: 76, with *Helix tudiculata* Binney (1843) as the type species. The family Helminthoglyptidae was proposed by Pilsbry (1939), which he divided into four subfamilies. One of them is the Helminthoglyptinae, which is confined to the Pacific States and includes the genera *Helminthoglypta*, *Monadenia*, and *Micrarionta*. Most subsequent authors have followed Pilsbry's classification. However, Burch and Pearce (1990) used an older name, Xanthonychidae, and van der Laan (1980) used Helicidae. Others have used Helicoidea as the superfamily (e.g., Smith et al., 1990). Roth (1996a) recently provided a phylogenetic analysis and new system of classification for the Helminthoglyptidae.

The genus *Helminthoglypta* is a large genus in which Pilsbry (1939) recognized 46 species plus 43 additional subspecies. These snails primarily inhabit California. Two of the species range north into Oregon and, according to Smith et al. (1990), 7 species range into or are limited to Baja California. This extensive speciation seems to reflect the low mobility of these snails combined with the complex topography and generally dry climate of California. This complex has been divided into four subgenera that were redefined by Roth and Hochberg (1992).

Helminthoglypta hertleini was first described as a distinct species by Hanna & Smith in 1937 (Nautilus, 51: 16, pl. 1, fig. c).

B. Species Description

1. Morphology

The species was described by Pilsbry (1939) as follows: “Helices of moderate or large size, the shell globose or depressed with conic or low spire and open or covered umbilicus; periphery rounded at all stages of growth. Embryonic shell 1 ½ to 1 3/4 whorls; after the smooth tip and a few radial ripples it has sculpture of close, microscopic, waved, radial wrinkles, over which there are papillae in forwardly descending trends (often indistinct or practically absent). Adult sculpture of simple growth lines or with spiral engraved lines, malleation, papillae or granulation also. A dark band revolves above the periphery (sometimes absent). Peristome narrow, expanded outwardly, usually reflected at base, dilated at columellar insertion.”

Pilsbry places this species in the subgenus *Helminthoglypta* sensu stricto and further defines it as a member of the *H. tudiculata* series. This series

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is described as follows: "Globose or globose-depressed, with sculpture of growth wrinkles below the suture, generally malleate in the peripheral region or throughout; not granulose, but sometimes with some granulation behind the lip; last whorl wide."

According to Hanna & Smith (1937) the shell morphology for this species is as follows: "Shell thin and delicate, pale golden brown, with a very narrow band of a darker shade, bounded below by an equally narrow band of a lighter shade; whorls five, regularly increasing in size; surface marked with fairly coarse growth ridges, and very irregularly scattered papillae; nuclear whorl with faint growth lines and a finely roughened surface; aperture not expanded; peristome simple and scarcely reflected (except in the umbilical region) and slightly thickened interiorly; umbilicus narrow, half covered by the reflected basal wall. Max. diameter 18.5 mm.; min. diameter 15.3 mm.; altitude 12.5 mm.; diameter umbilicus about 2 mm."

Further collecting from the type locality by Pilsbry indicates that the species diameter is up to 22.6 mm. He goes on to say that in comparing this species to other members of the *H. cypreophila* group, it is noted that it has lost the reflected peristome, and most of the surface markings; the bands are much less prominent and the shells are thin and delicate, somewhat like *tularensis* (Hemphill).

According to A. G. Smith *H. hertleini* lacks any distinct evidence of papillation, even on the nuclear whorls (in the Chace lot from Siskiyou County); otherwise it has all the earmarks of relationship to *tularensis*.

Pilsbry reported that "The umbilicus is far wider than in *H. napaea*, which also lacks papillae, and it seems to be an independent northern derivative of the *cypreophila* stock." Soft body anatomy is not required for field identification work. Refer to Hanna & Smith (1937) and Pilsbry (1939) for the descriptions.

2. Reproductive Biology

No data has been published on this species' reproductive biology. *Helminthoglypta* are hermaphroditic and lay eggs. Some inferences for the reproductive biology of this species can, however, be drawn from a study of a coastal species (*Helminthoglypta arrosa*) by van der Laan (1971, 1980). For example, within 24 hours after the first soaking rain in October the adult snails would emerge from estivation and begin mating, both at night and on overcast and rainy days. Although the coastal species was active at temperatures as low as 4EC, they only mated at ambient temperatures of 10 to 15EC. Their eggs were deposited in shallow holes in the soil below the leaf litter; the eggs averaged 2.2 mm in diameter and the mean number of eggs per egg mass was 75.6 (range 45-171). The young snails hatched in March and April.

3. Ecology

During the summer, the species will be found under rocks or large woody debris, which serve as refuge sites from desiccation. During the wet seasons, it may be found away from refugia, foraging for green vegetation and fruit, feces, old leaves, leaf mold and fungi. Mollusks that inhabit talus slopes also utilize the surrounding forest areas during moist, cool conditions, ranging out from the refugia to forage in litter of the adjacent forest floor. Vegetation within the surrounding forest not only moderates the temperature and moisture conditions within the rock habitats, but provides food, loose soil and litter conditions necessary for egg laying.

Generally, the lower one third of a talus slope contains the largest, most stable habitat elements. Because of the long-term stability in these areas and larger interstitial spaces between the rocks, microsite conditions are more favorable and provide dependable refugia sites. It is important, therefore, to avoid disturbance of the bottom of the slope that could result in loss of these refugia areas and destabilizion of the entire talus field.

The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate that results in the viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, snails and slugs represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active. Birds, beetles, shrews, mice, raccoons, carnivorous mollusks, and snakes are likely predators. The species are crepuscular (active only during dawn and dusk during the spring and fall seasons). Species of *Vespericola, Monadenia, Trilobopsis, and Haplotrema* commonly occur in the same geographic area as *Helminthoglypta*.

C. Range, Known Sites

The species is rare and known from a total of 16 sites. The **Type Locality** is along Route 66 east of Ashland, Oregon. It is known from the Klamath Province, including Jackson County, Oregon, on BLM Medford District, and Siskiyou County, California, with Shasta River sites on or adjacent to BLM land and near the eastern border of the Klamath National Forest. The species is expected to be found as far north as Douglas County, Oregon.

D. Habitat Characteristics and Species Abundance

The species is found in basalt rockslides (talus), under rocks and woody debris in moist conifer forests, and in shrubby areas in riparian corridors. No strong riparian association has been identified. Rocks and large woody debris serve as refugia during the summer and late winter seasons. Temperature is lower and humidity is higher under talus than in the surrounding environment. While the specific food requirements of this species is not known, a variety of vegetation, subsurface roots, fungi, and organic debris is typically found in talus slopes. Small invertebrates that may serve as food sources also inhabit the talus environment. Forest litter and coarse woody debris in the semi-dry areas in which these species occur is considered necessary to provide food (shelter and substrate for fungi) and temporary cover when foraging.

Population density at known sites has not been determined, as only 2 living specimens have been found. The species occurs with *Monadenia chaceana* at some sites.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage

According to the FEMAT report, the mollusk assessment suggests that the options considered in the outcome assessment were less effective in providing for mollusks than for any other species group. High degrees of endemism, rareness, and habitat specialization account, in part, for the low ratings. Under the selected management option (Option 9), there would be a 32% probability that the species would be well-distributed across Federal lands, a 27% probability that the species would remain viable but with gaps in distribution, a 30% probability that populations would be restricted to refugia, and a 12% probability that it would be extirpated (FEMAT Table IV-22).

At the time the ROD was signed, no sites were known on federal land. Though Riparian Reserves may provide some measure of protection (on sites that may be found on federal land), the species does not appear to have a strong association with riparian zones.

B. Major Habitat and Viability Considerations

This species to date, has only been found in rocky habitats, including talus. Maintaining refuge sites with appropriate microclimate conditions during the summer and winter within and around occupied habitat is considered critical. Retaining large woody debris, leaf litter, uncompacted soil, and canopy cover may assist in maintaining summer shade and refuge sites with respect to these habitat conditions.

The survival of mollusk species in semi-xeric (dry) conditions is especially dependent upon the presence of adequate refuge sites during the hot summer and cold winter months. An increase in temperature or decrease in moisture during the hot summer months is much more likely to adversely affect these subspecies than those that live in a mesic (moist) environment. The range of environmental conditions that these species can tolerate is not known. Desiccation is the most common cause of mortality for mollusks in general. These species are tolerant of drier conditions than are the subspecies of *Monadenia fidelis*.

The number of population sites required to maintain species viability is unknown; however, it can be assumed that the likelihood of species viability increases with the number of populations.

C. Threats to the Species

Given that little information is available about the habitat needs of the species, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities that increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means (including fire, herbicide use, recreation development, quarry development, road construction and major maintenance), over-collecting, and disturbance during aestivation may constitute a major threat to this species.

D. Distribution Relative to Land Allocations

Except the **Type Locality** on Medford BLM land, all known locations are on private land.

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The management goal for this species is to maintain the species across the known range by avoiding actions that would degrade occupied habitat or adversely impact the viability of existing populations.

B. Specific Objectives

- Maintain uncompacted soil in and near populated sites.
- Maintain undisturbed talus and rocky outcrops (most important in the lower third of the slope).
- Maintain vegetative community and shading in the population area.

- Maintain current volume of coarse woody debris as food sources (substrate for fungi) and refuge sites, and protect future sources of coarse woody debris.

- Maintain soil temperature and moisture regime of the refugia sites (cool and moist during the summer).

IV. HABITAT MANAGEMENT

A. Lessons from History

Knowledge of the species' range and habitat requirements is likely to change. Over-collecting has led to the extirpation of many species in Hawaii (Hadfield 1986), and caution should be exercised when surveying for this species in order to ensure that the activities do not inadvertently extirpate populations. Fire management activities that increased the intensity, duration, or frequency of fire; forest management activities that reduced shade, and road construction that directly disturbed sites have significantly impacted land snails in the Pacific Northwest.

B. Identification of Habitat Areas for Management

As of August 1998, it is considered important to protect all known occupied sites on public lands due to the relative rarity of this species. The Habitat Area will be identified as that area around known site locations, which includes all habitat features that contribute to environmental conditions important to the species at the known site. In most cases, this could be achieved by areas of tens of acres (ROD C-5). As new data is compiled, consideration should be given to daily and annual movements within the life cycles of the organisms.

C. Management Within Habitat Areas

In general, manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi.

- maintain undisturbed talus, especially in the lower third of a slope

- maintain native vegetative cover to provide shade and moderate temperature and humidity, and to provide a basis for food resources

- manage forested areas within the Habitat Area to provide shade, coarse woody debris and uncompacted forest litter.

- protect sites from wildfire events

D. Other Management Issues and Considerations

Prescribed fire may be considered as a tool to be used outside of Habitat Areas to reduce the risk of catastrophic natural fire. Prescribed burning should be designed to avoid significant impacts to the habitat conditions in the management area as outlined in Section II-B.

Consideration should be given to locating and managing additional sites and determining the actual biogeography of the species.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

Current knowledge of this species is based on limited collecting from 2 known population areas. The species' present and former distribution, and the factors that have controlled distribution, diet, reproductive rates, and dispersal rates need further investigation. Local and range-wide population trends are not known.

Field research associated with any mollusk species often results in detections in different habitats than expected based on prior knowledge. Range extensions are also common. Surveys outside of known habitat conditions may be helpful in determining the full range of habitat conditions in which the organisms can survive.

B. Research Questions

- What are the food requirements of this species, and are any of these food requirements unique to the species?
- What is the range of environmental conditions that this species can tolerate, and how long can extremes be tolerated?
- Are there other populated sites?
- What factors control the species' rate and distance of dispersal?
- What is the species' natural life span?

- What adaptations has the species made that allows it to be xeric tolerant?
- What is the actual physical range of the species?
- How far does an individual range away from its refuge site?
- What is the population density of the known sites?

C. Monitoring Needs and Recommendations

Known sites on public land should be monitored to assess population trends and to attempt to determine the factors that control those trends. Monitoring strategies should be designed to assist in determining if the implementation of the plan is resulting in the protection of habitat for these species. In addition, monitoring should be designed to ensure that site disturbance or collection activities do not extirpate local populations.

VI. REFERENCES

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SECTION NO. 5
Helminthoglypta talmadgei
Trinity Shoulderband

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Management Recommendations for *Helminthoglypta talmadgei*, the Trinity Shoulderband (land snail)

V. 2.0

by

John S. Applegarth

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EXECUTIVE SUMMARY

Species: *Helminthoglypta talmadgei* Roth, 1988 — the Trinity Shoulderband (land snail)

Taxonomic Group: Mollusks

ROD Components: Survey Strategies 1 and 2

Other Management Status: none

Range: *Helminthoglypta talmadgei* has a patchy distribution in the Klamath Mountains of northern California. Most sites are along the Trinity River from Junction City to the Klamath River, plus one site at Orleans on the Klamath River, one on the South Fork of the Trinity River, six in the mountains south of the Trinity River (Trinity County), and a cluster of sites on the South Fork of the Salmon River. This species is known or suspected in Big Bar, Hayfork, Weaverville (Trinity County), and Yolla Bolla (Trinity County) Ranger Districts of Trinity National Forest, Lower Trinity and Orleans (Humboldt County) Ranger Districts of Six Rivers National Forest, Salmon River and Ukonom Ranger Districts in Siskiyou National Forest, and Bureau of Land Management lands (Trinity County).

Specific Habitat: On south-facing slopes this moderately large snail is usually associated with rock talus. Proximity to a stream and partial shading by trees and bushes may be needed to moderate temperatures and reduce evaporative loss within rock talus. On north-facing slopes this snail can live on the forest floor away from streams, does not seem to need rock talus, and finds shelter under woody debris, moss, and leaf mold. The availability of herbaceous plants that are accepted as food may limit the distribution and abundance of this species.

Threats: Possible threats to the generally small and isolated populations of this snail include reduction of trees in and around inhabited sites, destabilization of inhabited rock talus slopes, application or spilling of chemicals, invasions by nonnative species, and direct effects of fire.

Management Recommendations: Each occupied known and newly discovered site for this snail should each be managed by establishment of a Habitat Area around occupied locations that is of a size sufficient to maintain the existing environmental conditions at the site. Until the needs of this species are better understood, a cautious approach is recommended. Existing vegetation and woody debris should be conserved. Inhabited rock talus should not be destabilized. Fire should be avoided within Habitat Areas and used cautiously to reduce hazardous fuels outside of Habitat Areas. Ground disturbance, soil compaction, and use or spilling of chemicals need to be avoided.

Information Needs: There is a need to develop survey methods that are efficient but not damaging to rocky habitats. Little is known about the ecology and life history of this species. The continued survival of this species should be monitored at managed locations.

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

The family Helminthoglyptidae was proposed by Pilsbry (1939), which he divided into 4 subfamilies. One of them, the Helminthoglyptinae, is confined to the Pacific States and includes the genera *Helminthoglypta, Monadenia,* and *Micrarionta.* Most authors have followed this classification by Pilsbry (e.g., Turgeon et al. 1998). However, Burch and Pearce (1990) used an older family name, Xanthonychidae, and van der Laan (1980) used Helicidae. This family is usually placed in the superfamily Helicoidea (e.g., Smith et al. 1990). Roth (1996a) recently provided a phylogenetic analysis and new scheme of groups within the Helminthoglyptidae.

The genus *Helminthoglypta* was named by Ancey (1887), with *Helix tudiculata* Binney (1843) as the type species. This is a large genus in which Pilsbry (1939) recognized 46 species plus 43 subspecies. These snails primarily inhabit California. Two species range into Oregon and, according to Smith et al. (1990), 7 range into or are limited to Baja California. This California speciation seems to reflect the low mobility of these snails combined with the topography and generally dry climate of California. This genus includes 4 subgenera that were redefined by Roth and Hochberg (1992).

Helminthoglypta (*Helminthoglypta*) *talmadgei* was named by Roth (1988), who placed this species in the genus and subgenus *Helminthoglypta.* The type specimen (Santa Barbara Museum of Natural History, SBMNH 34897) was collected by Barry Roth on 1978 May 24 in a limestone rockslide on the north side of California Highway 299 at 0.4 road mile (0.64 km) southeast of Del Loma, Trinity County, California. This is the type locality. The key in Pilsbry (1939) does not include this species. There is a small key in Roth (1996b, repeated in Furnish et al. 1997) that separates this species from 3 species of coastal Humboldt County. Another species found close to this species is *Helminthoglypta cypreophila*, which may have the umbilicus slightly more than half covered by the reflected shell lip. Because shells of these species are similar, it is recommended that identifications be confirmed by a regional expert.

There are no subspecies and none is anticipated.

The English name for this land snail is Trinity Shoulderband (Turgeon et al. 1998). An earlier name was Klamath Shoulderband (Turgeon et al. 1988)

B. Species Description

1. Morphology

Helminthoglypta talmadgei is a moderately large land snail. Mature examples have shells that are 18.2 to 28.0 mm in diameter (Roth 1996b, who does not include the outward turned lip in measurements of shell diameter). The following description from Roth (1996b) is repeated in Furnish et al. (1997) who also provide a glossary of terms. The mature shell is relatively thin-walled, depressed-helicoid in shape, and has 5.2-6.1 whorls. The spire is broadly conical. The suture between whorls is moderately impressed, with the upper surface of each whorl somewhat flattened. In side view, the periphery of the shell is rounded or slightly compressed toward the axis. There are about 1.75 embryonic whorls. As for surface texture, the post-embryonic whorls have coarse collabral rugae, incised from the fourth whorl on by fine spiral striae and disrupted by irregular malleation (small dents). The striae are strongest on the shoulder of the body, or outer whorl. However, the body whorl is sometimes nearly smooth, especially below the periphery, and gently descending behind the lip. The base of the shell is malleated and inflated-looking around the umbilicus. The diameter of the shell divided by the diameter of the umbilicus is 14.5. The aperture (mouth of the shell) is broadly ear-shaped, with a smooth varix (rib) inside the lip, which is turned outward and thickened, most strongly at the base of the shell. The inner lip covers less than half of the umbilicus. Shell luster is matte to silky. The color of the mineral shell is pale pinkish tan under a golden brown periostracum; the crests of the malleations are lighter.

The appearance of the shell of *Helminthoglypta talmadgei* was described and photographically illustrated by Roth (1988). Shells of many of the other species in this genus were illustrated by Pilsbry (1939). There is a narrow, roughly 1 mm wide dark, russet-colored band on the shoulder of the shell that becomes incorporated into the suture, except where there is a slight downturning of the last whorl of mature shells, in such a way that the suture angles down below this dark band for a short distance. There are traces of pale zones, each about 1 mm wide, both above and below the dark band. Hence the English name of "shoulderband snail" for all species in this genus (Turgeon et al. 1988, 1998).

Roth (1996b) described the color of the exposed soft parts as tan, shading to gray on the dorsum, or medium-gray with a purplish cast. The mantle over the lung is clear buff with black spots covering 25-30% of its surface. Internally, the common duct of the mucus glands is slender; the mucus bulbs are large and spindle-shaped. The penis is cylindrical; the upper chamber is of the same diameter as the epiphallus at its junction; while the lower chamber has two longitudinal pilasters and a small papilla at the summit. The epiphallic caecum is about 0.5-0.6 times as long as the penis plus epiphallus. The spermathecal diverticulum is about equal to considerably longer than the spermathecal duct above its origin.

2. Reproductive Biology

For *Helminthoglypta talmadgei* there seem to be no direct observations on potential longevity, generation time, the number and appearance of the eggs, or situations used for oviposition. Roth (1988) provided a description and illustration of the reproductive anatomy of this species, which was summarized by Roth (1996b and above). Walton (1963, 1970) found that captive *Monadenia fidelis* mature in about 2½ years, can produce multiple sets of young, and have a potential life span of at least 8 years. Although *Monadenia fidelis* are somewhat larger, they are in the same family as *Helminthoglypta.* Van der Laan (1971) found that other species of *Helminthoglypta* can live over 4 years. These reports suggest that *Helminthoglypta talmadgei* may live long enough to have multiple opportunities to reproduce, which could favor the stability of populations.

Four hatchling *Helminthoglypta talmadgei* were found on September 1, 1998 in alder woods of an unnamed tributary of Packers Creek (locality #18 in Appendix A). This suggests that young are born earlier in the year and that some eggs may be deposited within riparian zones. Inferences for the reproductive biology of this species can also be drawn from a study of a coastal species (*Helminthoglypta arrosa*) by van der Laan (1971, 1980). For example, within 24 hours after the first soaking rain in October the adult snails would emerge from estivation and begin mating, both at night and on overcast and rainy days. Although the coastal species was active at temperatures as low as 4EC, they only mated at ambient temperatures of 10 to 15EC. Their eggs were deposited in shallow holes in the soil below the leaf litter, the eggs averaged 2.2 mm in diameter, and the mean number of eggs per egg mass was 75.6 (range 45-171). The young snails hatched in March and April.

3. Ecology

Rock talus may benefit *Helminthoglypta talmadgei* in several ways. By creating a permanent opening (“light gap”) within an otherwise dense conifer forest, a rock talus may favor this mollusk by being a reliable location where small amounts of herbaceous plants will always grow. Possibly more important may be the cool and damp microclimate within a rock talus, and this may be especially important for south-facing slopes that could otherwise be too hot and dry for this species. Rocks and other forms of cover may also help snails avoid detection by predators. Possible predators include snail-eating carabid beetles (*Scaphinotus*), alligators lizards (*Elgaria*), garter snakes (*Thamnophis*), and a variety of small mammals. If these snails climb up any vertical surface (a rock or the base of a tree), they may avoid detection by predators that roam horizontal surfaces (an observation on another species of shoulderband snail by van der Laan, 1975b). Snails in this genus can produce an epiphragm (a seal of dried mucus in the mouth of the shell) to reduce water loss during seasonal periods of inactivity (summer and winter), and this behavior has been noted for this species (Mary Gausen, personal communication). Whether or not this species will clamp onto rocks and other surfaces for protection during dormancy is not known. As noted by van der Laan (1980), high moisture availability is absolutely necessary for these snails to be active, and their feeding is facilitated by dampness. *Helminthoglypta* are herbivorous and prefer to feed on certain herbaceous plants while rejecting others. Although they will eat live plants, they strongly prefer to consume the dead remains of those same kinds of plants. These snails do not feed on grasses, certain fungi, and plants with toxins, but spines are generally only an obstacle when the plant is upright and the snail would have to climb in order to feed (van der Laan 1975a). The availability of suitable herbaceous food plants may be a limiting factor in the abundance and distribution of this snail. Recent observations of a local abundance of this species suggests that wildfire can produce a bloom of herbaceous vegetation that in turn may support a bloom in the sail population. As the forest recovers, the snail population could fall back to a low level, but during the bloom this species may be able to disperse to other locations (a fire associated connectivity).

C. Range, Known Sites

Typical of the genus, *Helminthoglypta talmadgei* seems to have a relatively small distribution. This land snail inhabits the Klamath Mountains in the adjacent parts of Humboldt, Siskiyou, and Trinity counties of northern California. This range is entirely within the range of the Northern Spotted Owl. This snail seems to have a patchy distribution that may be influenced by the distribution of areas having supplies of herbaceous vegetation, such as talus slopes, riparian zones, and north-facing slopes. Most of the historic sites (in the Known Sites database) are along both sides of the Trinity River, from the vicinity of Junction City down to its confluence with the Klamath River, plus one record from the South Fork of the Trinity River, and scattered locations in the mountains south of the Trinity River within Trinity County. Roth (1988) provided an additional record from mine tailings at Orleans (roughly 10 miles up the Klamath River). Recent surveys have discovered a local abundance of this snail on the north side of the Salmon Mountains, on forested north-facing slopes near the South Fork of the Salmon River in Siskiyou County (records #23-25 in Appendix A).

Although a large part of the south side of the Salmon Mountains is in the Trinity Alps Wilderness, a survey sampled 11 localities north of the Trinity River (south side of the Salmon Mountains) for another rare snail, *Monadenia setosa*, and did not find any *Helminthoglypta talmadgei* (Roth and Eng 1980; Roth 1982; Roth and Pressley 1986). On the other hand, south of the Trinity River they found this species at 4 of the 16 sites they surveyed. There are 3 other records for this species in the mountains south of the Trinity River that also support this asymmetrical pattern relative to the Trinity River.

Because there is a geographic mosaic of the many species of *Helminthoglypta* in California, and there are other species in the areas adjacent to the range of this species, surveys for this species were thought to be needed only in the Big Bar, Hayfork, Weaverville (Trinity County only), and Yolla Bolla (Trinity County only) Ranger Districts of the Shasta-Trinity National Forests, the Lower Trinity and Orleans (Humboldt County only) Ranger Districts of the Six Rivers National Forest, and Bureau of Land Management lands in Trinity County. The recent discovery of this species near the South Fork of the Salmon River expands the known and suspected range of this species to include the Salmon River and Ukonom Ranger Districts of the Klamath National Forest. There may be some apparent overlap of ranges because separate colonies of different species may share the same watershed, as has been noted for the South Fork of the Salmon River (Mary Gausen, personal communication).

If the known range of this species were purely a reflection of where people have chosen to search, then a low elevation distribution might be expected because most good roads are along the major rivers. However, *Helminthoglypta talmadgei* seems to be more of a montane species in contrast to several lowland species of shoulderband snails that inhabit the adjacent coastal areas of northern California. Records indicate this species has a tendency to inhabit intermediate and higher elevations. Of the 25 locations (Appendix A), 5 are below 1000 feet, 8 are above 2000 feet, 4 are above 3000 feet, 2 are above 4000 feet, and the highest is a fairly precise location at 1500 meters (4921 feet). This species may range as high as there are rock talus slopes and streams that create openings in the coniferous forests of the Klamath Mountains.

D. Habitat Characteristics and Species Abundance

Many *Helminthoglypta talmadgei* sites involve limestone rock talus. Specific habitat notes include mention of rocks or limestone talus (at 9 of the 25 locations in Appendix A, and account for at least 36 specimens), proximity to a stream or spring (at 9 of the 25 locations, and account for at least 21 specimens), and partial shading by conifer forest (at 6 locations, and 61 specimens). One location (#21) was described as a rockslide on a steep, south-facing cut bank in an open stand of mixed evergreen forest, with a cover of sparsely distributed shrubs of *Rhus diversiloba* and *Ceanothus*. At the type locality (#1), snails were in a south-facing limestone rock slide, mostly in more stable portions of slides where soil had not filled in between stones, and most were in partial shade. Of the records that mention rock talus, most were south-facing and none were north-facing. Of the records from north-facing slopes, none mention rocks. Of the records that mention proximity to a spring or stream, all aspects were involved.

Shelter and moisture may be especially limiting for this snail on south-facing slopes. All specimens from south-facing slopes were found in rock talus, usually where there were some trees or bushes for partial shade and sometimes near a spring or stream. A nearby stream may contribute to dampness in the ground and may cool the local air. In south-facing situations, a favorable microclimate for this species may depend on having some trees in and around each inhabited location. Not only will partial shading by trees moderate temperatures within the rock talus, but the trees should also act as a windbreak, reducing the extent to which wind can accelerate the loss of moisture from within the talus. Trees and bushes may also be important as sources of organic debris that contribute nutrients to the local herbaceous plants on which these snails feed.

In contrast, some recent records from north-facing slopes (locations #23-25 in Appendix A) suggest that in those situations these snails can find adequate shelter and moisture under woody debris, under moss on the base of oak trees, and in decaying vegetation under sword ferns and clumps of fescue grass (Mary Gausen, personal communication). There was no restriction of this species to the proximity of streams. No areas of rock talus were observed; instead the whole area has a gravelly soil. No limestone was noted (the area is Pre-Cretaceous metamorphic rock with some areas of Mezozoic ultrabasic intrusive rock). Although these locations are forested, a major forest fire swept through this area in the late summer of 1987. Charred bark on some surviving trees indicates flame lengths exceeded 15 meters (50 feet). Such a hot fire may have caused a high mortality of mollusks because there were no rocks for cover. In November 1998, surveys in this area found at least 3 kinds of snails and 2 kinds of salamanders. Presumably these species survived either by being underground or in unburned pockets within this widespread fire. What is remarkable is the present abundance of this otherwise rare snail (it was found at 23 of 25 Sample Areas). Snails that survived the fire could have generated millions of descendants in 12 years, if there were no limitations. Although the present abundance of this snail suggests that it benefitted from a post-fire bloom of herbaceous vegetation, the forest has been recovering and the canopy closing, so the supply of herbaceous vegetation and the abundance of this snail may have peaked and are now declining. The vegetation at these new locations included Douglas-fir, ponderosa pine, sugar pine, bigleaf maple, all 3 species of oak, hazel, wild raspberry, and sword fern. Near a ridge top there was manzanita and ceanothus (buckbrush), but this snail was found there as well.

Older records indicated *Helminthoglypta talmadgei* was a rare species with a patchy distribution. Of the 24 successful collecting efforts (prior to 1998), 20 produced only one to three specimens, and there was a total of about 62 specimens (including immature specimens and fragments). During intensive surveys for *Monadenia setosa* (Roth and Eng 1980; Roth 1982; Roth and Pressley 1986), *Helminthoglypta talmadgei* was found at only 7 of 38 locations (within the range of this species), which is evidence for a patchy distribution. The new results show this species can have colonies where this species is locally abundant. The recent surveys also found a colony of a different species (*Helminthoglypta cypreophila*) that is farther east along the South Fork of the Salmon River, so *Helminthoglypta talmadgei* also seems to be patchy on the north side of the Salmon Mountains. To what extent north-facing slopes can sustain denser populations of this species than south-facing situations is not known at this time.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage Standard and Guideline

The range of *Helminthoglypta talmadgei* is entirely within the range of the Northern Spotted Owl. In the FEMAT report (USDA . . ., 1993, page IV-128) this species was judged to have a 7% risk of extirpation under Option 9. This land snail has a limited distribution in the Klamath Mountains of northern California where it seems to be generally rare at scattered locations, most of which are on National Forest land. The degradation of favorable habitat features, including the destabilizing of rock talus and the loss of shade-producing trees and bushes, could contribute to local extirpation.

B. Major Habitat and Viability Considerations

The primary concern for *Helminthoglypta talmadgei* is the conservation of known populations by means of protectively managing their known areas of occupied habitat. When contrasted to vertebrate species, mollusk populations are relatively sedentary, and habitat connectivity is of little importance to their immediate survival. “If protected from catastrophes, snail colonies may not depend on immigration and could conceivably be self-sustaining for centuries – in which case the distance to the next fragment [of suitable habitat] may not be very important” (Roth 1993). “Even patches of a few hundred square meters could support ‘reservoir’ populations if appropriate habitat structures . . . were maintained” (Roth 1993). What is most urgent is to identify occupied areas and then conserve favorable structures and conditions. It should be recognized that this snail depends on the health of the local ecosystem, which in turn depends on connectivity with adjacent communities both terrestrial and aquatic. Also, there is a possibility that fires may create a transient connectivity for this snail by allowing herbaceous plants to become broadly abundant, temporarily. As a moderately large land snail, this species may be relatively more mobile and more capable of opportunistic dispersal and seasonal movements than most of the other land snails.

C. Threats to the Species

A possible threat to the generally small and isolated populations of *Helminthoglypta talmadgei* is the partial or complete removal of trees from in and around inhabited areas. Especially on south-facing slopes, trees and brush may be needed for the cooling effect of partial shading and to provide windbreaks that reduce the drying effect of wind at ground level (dehydration is a major threat to terrestrial mollusks). Woody debris may be important in the local food chain by providing nutrients to fungi and herbaceous plants. This snail, other mollusks, and plethodontid salamanders of the forests of the Pacific Northwest seem to have similar habitat requirements, and the importance of conserving standing trees both within and around talus slopes inhabited by salamanders was emphasized by Herrington and Larsen (1985).

Another threat to those snails that live within rock talus is the destabilization of those slopes. This could occur if roads or trails are built across the slopes. A greater threat occurs when there is a substantial amount of rock or soil removed from the foot of the slope for use elsewhere, because that will destabilize the entire slope. At the type locality, where there seemed to be a modest concentration of *Helminthoglypta talmadgei*, the snails are mostly in the more stable portions of the talus.

Other possible threats to the local survival of this snail include application or spilling of chemicals, including pesticides, herbicides, fertilizers, and fire-fighting chemicals. Nonnative species could threaten isolated populations of this rare snail. In southern California, an Endangered species, *Helminthoglypta walkeriana* or the Morro Shoulderband, may be limited by competition with the European Garden Snail, *Helix aspersa*, in a habitat that has been degraded by alien plant species (USDI . . ., 1994).

Finally, both wild and planned fires can directly kill these snails and remove needed vegetation. However, if enough snails survive to repopulate a location, there can also be benefits. Prescribed fires in adjacent areas can reduce the risk of wildfire within inhabited areas. If a snail colony survives a fire, apparently there can be a bloom in the number of snails in response to a bloom of the herbaceous vegetation after a fire. Although the forest canopy may recover and shade out most of the herbaceous plants, this post-fire broad availability of its food resource may enable this species to disperse and reach other locations that can provide food and shelter on a long-term basis.

D. Distribution Relative to Land Allocations

Most of the known locations for *Helminthoglypta talmadgei* are on Federal land within the Siskiyou, Six Rivers, and Trinity National Forests, fewer sites are on private land, three (#2, #7, and #13 in Appendix A) are on the Hoopa Valley Indian Reservation, and one location (#8) may be on Bureau of Land Management land. Some records (including #8) are not sufficiently precise to allow clear identification of land ownership. The site at Natural Bridge (#15) is within the Hayfork Adaptive Management Area (AMA). Some of the locations along the north side of the Trinity River (including #1, #5, #6, #10, #12, #19, #20 and #21) may also be within the Hayfork AMA, and all are within the Wild and Scenic River Area. The Barker Creek location (#16) is said to be in section 16, which is private land, but this is suspected of being an error for section 21 or 28, which are both in the Hayfork AMA. Within its range this species should be anticipated in all land allocations.

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The goal for management of the Trinity Shoulderband, *Helminthoglypta talmadgei*, is to assist in maintaining the viability of known and newly discovered populations of this species.

B. Specific Objectives

The specific objectives for *Helminthoglypta talmadgei* should be to identify and manage inhabited areas in ways that will maintain the ecological framework on which this species depends, so it will have the opportunity to survive on a long-term basis.

Specific management objectives for areas inhabited by this species should include

- conservation of favorable temperature and moisture conditions;
- conservation of herbaceous plants that are important as food;
- conservation of woody debris and other decaying plant matter;
- conservation of slope and rock talus stability;
- protection from the negative impacts of fire;
- avoidance of ground disturbing or soil compacting activities;
- avoidance of herbicides, pesticides, and other chemicals; and
- control of nonnative plants and animals as needed.

IV. HABITAT MANAGEMENT

A. Lessons from History

Land snails in the genus *Helminthoglypta*, the shoulderband snails of California, are a complex of many species, each of which has a relatively small range and each species is, therefore, relatively vulnerable to extinction as environmental conditions change. Because of this pattern, and because other species of *Helminthoglypta* occupy lands adjacent to the range of this species, *Helminthoglypta talmadgei* is not expected to range much beyond the region now known to be inhabited. This species was found at only 7 of 38 sites in this area during intensive surveys for *Monadenia setosa* (Roth and Eng 1980; Roth 1982; Roth and Pressley 1986), so the number of additional colonies of *Helminthoglypta talmadgei* that remain to be discovered on Federal lands may be relatively few. Another species in this genus, *Helminthoglypta walkeriana*, has reached the brink of extinction (USDI . . ., 1994) as a result of habitat degradation by drought, domestic livestock, fire, exotic plants, and competition with an exotic snail.

B. Identification of Habitat Areas for Management

Occupied known and newly discovered *Helminthoglypta talmadgei* sites that are on Federal lands and defined with adequate precision should be managed to favor the long-term survival of this generally rare forest floor snail by means of Habitat Areas. The word “site” refers to the defined point location where one or more shells and/or live snails of this species have been found. A point location can be the marked feature in a Sample Area (or Plot) where one or more examples were found, or the isolated site of a Point Search, or the center of a group of sightings within 10 meters (33 feet) of each other (and defined by UTM coordinates that are at least 10 meters from the next site). Ten meter intervals generally are the smallest units that can be reliably derived from a USGS topographic map when defining the UTM coordinates for such a location.

As of January 1999 there do not seem to be enough records or habitat information to qualify this species as “fairly well-distributed” in any part of its range and, until more is known about which plants are eaten by this snail, it would be difficult to design general management procedures that could be expected to conserve or improve the habitat.

Therefore, the currently appropriate management for this species should be by means of individual Habitat Areas, one for each site. Although the interagency ROD (USDA . . ., 1994, page C-5) speaks of management areas that are “on the order of tens of acres,” an individual Habitat Area that should favorably conserve conditions for this species can be smaller, on the order of 10 acres (4 hectares) unless limited to a smaller area by topography (rivers and ridge tops), ownership, or major (paved) roads. A Habitat Area of this approximate size should have a substantial interior where soil temperature and moisture variations are moderated at the ground level.

Larger areas may be needed for sites on south-facing slopes or for historical sites that are not as precisely defined as newly discovered sites, or if there are multiple sites in a rock talus that suggest the entire slope should be protectively managed.

C. Management Within Habitat Areas

Within Habitat Areas that have been identified around occupied known or newly discovered sites for *Helminthoglypta talmadgei*, management actions should favor the long-term survival of this species. Because little is known about the ecology of this snail, a cautious approach is recommended. The existing trees, canopy closure, and surface vegetation within each Habitat Area should be conserved as much as possible in order to provide favorable microclimate and food supply at each protected site. Domestic livestock should not be allowed to trample or consume substantial amounts of herbaceous vegetation in Habitat Areas. Because there should be no substantial removal of woody debris from within Habitat Areas, campsites and recreational facilities should not be located nearby. Because inhabited talus slopes should not be destabilized, a new trail or road should not be built across an inhabited talus slope, and substantial quantities of rock should not be removed from the foot of an inhabited talus slope. Prescribed fire should be avoided within identified Habitat Areas, but hazardous fuels in adjacent areas should be managed to reduce the risk of the negative impacts of a wildfire. Ground disturbing and soil compacting activities should be kept to an absolute minimum within Habitat Areas. Avoid the application or the risk of spilling potentially harmful amounts of chemicals, including herbicides, pesticides, fertilizers, and fire-fighting chemicals. If nonnative plants or animals threaten to damage a Habitat Area, control should be by biological or mechanical means. As more information becomes available, this guidance should be adjusted to accommodate the specific needs of this mollusk and the particular species of plants on which it feeds.

D. Other Management Issues and Considerations

A general policy of conserving or developing favorable habitat for this species could eventually replace the present standard and guideline of protectively managing known sites. A general policy ought to provide more benefit to the long-term survival of this species than the management of only those sites where the particular individuals happened to be detected by the sampling procedure of the survey protocol.

Although those snails living within south-facing rock talus slopes may be somewhat safe from the direct effects of fire, and those snails near the South Fork of the Salmon River seem to have increased in number after a wildfire, there remains the risk that fire may contribute to the extirpation of a colony either by direct mortality or through the loss of needed vegetation and woody debris. Therefore, it is suggested that broadcast burning be avoided in directly adjacent areas, that firebreaks be put around Habitat Areas as needed, and that some slash piles be left unburned in adjacent areas (because these snails may be attracted to slash piles as cover). Unfortunately there does not seem to be an ideal time for prescribed fires because snails are less likely to be in safe locations during the cooler parts of the year. (Unless some go down rodent holes, snails living away from talus may be vulnerable to being killed by fire at any time of year.)

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

A. Data Gaps and Information Needs

Very little is known about the ecology of *Helminthoglypta talmadgei*. Observations are needed to better define the habitat associations and food preferences of this snail. This species seems to be relatively rare at most known locations. Of the 24 successful searches in the Known Sites database, 19 searches found only 1 to 3 examples. If monitoring for this species is going to be effective, especially in rock talus situations, there is a need for survey methods that do not involve extensive moving of rocks, which could degrade habitats and possibly destabilize slopes. One possibility is to visually survey with the aid of a portable spotlight on wet nights in early winter or spring. Another is to set out squares of plywood ("placements") and then look under them at intervals of a day or more. These methods have been used to detect amphibians and reptiles and are discussed further in Applegarth (1994). Also there is a need for a field-friendly key (using external features only) that includes all of the species of *Helminthoglypta* within the range of the Northern Spotted Owl.

B. Research Questions

Does this snail benefit from limestone or other alkaline substrates?
Are snail colonies on south-facing slopes dependent on rock talus?
Can a post-fire bloom of herbaceous plants actually facilitate dispersal?
Are there any major threats to this species from recreational activities?
What shell or external body features can be used to reliably identify this species?
Is this snail really absent from the south side of the Salmon Mountains?
How high does this species range (is it limited by timber line)?
Are any known sites being adversely affected by nonnative plants or animals?
What feeding habits and predators does this snail have?

How far can individual snails move on a daily or seasonal basis?
Does this species occur together with any other species of *Helminthoglypta*?

C. Monitoring Needs and Recommendations

Known and newly discovered sites for *Helminthoglypta talmadgei* on Federal lands should be monitored (1) to assess compliance with the Survey and Manage standard and guideline, (2) to evaluate the habitat impacts of all management activities in and near these locations, and (3) to verify the continued existence of this species within each managed Habitat Area. If there are colonies of this snail within areas being studied in the Hayfork AMA, it is suggested that the monitoring of the responses of those colonies be incorporated into the research design. In general, monitoring surveys for this species should be limited to detecting presence and should be done when season and conditions are suitable for mollusk surveys. An empty shell or fragment should be accepted as evidence for presence (most empty shells will be destroyed by scavengers, weather, and plant roots within a year or two). Of the historic records in the Known Sites database (version 2.0), the most recent year this species was detected is 1981, so verification of continued existence at historic sites could aid viability estimates.

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APPENDIX A

Following is an annotated list of the 6 known locations for the Trinity Shoulderband (land snail), *Helminthoglypta talmadgei*. The first location is the type locality, and the rest are arranged by the first date they were visited. After the location number (and the record ID number or numbers from the Known Sites database) there is a brief description of the location, followed by the date(s) of collection and number of specimens (plus the museum acronym or name of specimen holders and their catalog numbers, if any). The added annotation includes any corrections or questions, an estimate of the UTM coordinates, an estimate of the elevation, the name of the USGS 7½-minute topographic map, the land ownership (estimated from Forest Service recreation maps), and the level of precision code (plus the original code if it seems incorrect). In the Known Sites database all records were graded as to how accurate the description of location seemed to be, and a corresponding letter code was entered in the "precision" field. These codes are S = "second record" (location description is accurate to ±150 feet), M = "minute record" (accurate to ±1.5 miles), G = "general record" (accurate to ±5 miles), and V = "vague record" (cannot be located within ±5 miles). The "mappable" locations are hereby defined as those with an M or S level of precision.

#1 (record ID 95000104, 95000110, 95000116, 97000065, 97000066) **Type locality —** California, Trinity County, **0.4 road mile southeast of Del Loma**, limestone rockslide from road to 250 feet upslope. 1978 May 23-24 and 1980 October 25 (3 visits). Eleven specimens (SBNHM 34896-34897; Roth 985, 990, 1221). UTM are about 472200 E and 4513600 N; elevation is 350-400 m (1148-1312 ft); USGS map = Del Loma, CA, 1982; land is Federal (Trinity National Forest, Big Bar Ranger District); and precision = S.

#2 (95000114) California, Humboldt County, **Blue Slide**, spring on California Route 96, Hoopa Valley Indian Reservation. No date. One specimen (Roth 1054). According to the Humboldt County Sheriff's Office in Hoopa, Blue Slide is directly across the Trinity River from the Hoopa Valley Landing Strip; the only draw is presumed to contain the spring, which is in center of north quarter of section 36 in T. 8 N, R. 4 E; UTM are about 443580 E and 4543070 N; elevation is about 116 m (380 ft); USGS map = Hoopa, CA, 1979; land ownership is Hoopa Valley Indian Reservation; and precision = S (not G).

#3 (95000109) California, **Humboldt and Trinity counties**, scattered locations, in rocks. 1950-1951. Three specimens (Roth, unnumbered). Precision = V.

#4 (not in Known Sites database) California, Humboldt County, **mine tailings at Orleans**. 1954 April. Two specimens (Los Angeles County Museum of Natural History, LACM 114640). Record from Roth (1988); UTM (below Owl mine) are roughly 452500 E and 4571500 N; elevation (below Owl Mine) is roughly 183 m (600 ft); USGS map = Orleans, CA, 1978; land could be private or Federal (Six Rivers National Forest, Orleans Ranger District); several mines are roughly 1.5 miles from centrally located airstrip but most likely seems to be the Owl Mine on the west edge of town, so precision = M.

#5 (95000113) California, Trinity County, **Hawkins Creek**, east side of Trinity River, Hawkins Bar. 1960 March. Three specimens (Roth 1023). Location could be either section 20 or 21 of T. 6 N, R. 6 E; within Trinity Village there are multiple roads along which this series could have been collected; UTM are roughly 456500 E and 4525000 N; elevation is in the range of 213-427 m (700-1400 ft); USGS map = Salyer, CA, 1979; land ownership is probably private but could be Federal (Six Rivers National Forest, Lower Trinity Ranger District); and precision = M.

#6 (95000042) California, Trinity County, about **5 miles west of Del Loma**, above [upslope] California Route 299. 1960 and 1961, January through March of both years. Twelve specimens (Roth 1039). Location could be in section 20 or 21 of T. 5 N, R. 7 E; UTM are roughly 466000 E and 4516000 N; elevation is roughly 320-400 m (1050-1312 ft); the USGS map = Ironside Mountain, CA, 1982 (no section lines); land could be private or Federal (Trinity National Forest, Big Bar Ranger District); and precision = M.

#7 (97000098) California, Humboldt County, **Hoopa**. 1960 April. Two specimens (CAS 32007). Possibly this location is Blue Slide in section 36 (not 25) at the same site as locality #2 above (this speculation is based on local topography); otherwise UTM are about 443000 E and 4543000-4544000 N; elevation would be roughly 122 m (400 ft); USGS map = Hoopa, CA, 1979; land is Hoopa Valley Indian Reservation; and precision = M.

#8 (95000115) California, Trinity County, **Junction City**. 1978 March [13]. One specimen (Roth 947). If this snail was found at Junction City, then it would have been in section 7; according to Roth (1988 and personal communication) the collection date is March 13 (not March 12), UTM are roughly 496000 E and 4509000 N; elevation is roughly 500 m (1640 ft); USGS map = Junction City, CA, 1982; land ownership could be either private or Federal (Bureau of Land Management); and precision = M.

#9 (95000105) California, Trinity County, **10.2 miles E of Big Bar**. 1978 March 12. One specimen (Roth 967). Distance is presumed to be road miles via California Route 299, which places this location in section 34 (according to a map measuring wheel), so UTM are about 492000 E and 4512000 N; elevation is about 440 m (1444 ft); USGS map = Dedrick, CA, 1982; land ownership seems to be private; and precision = M (not G).

#10 (95000038) California, Trinity, in the range of 10-200 feet **east of Swede Creek**, slope above California Route 299. 1978 March 12. One shell fragment (Roth 948). UTM are 470100 E and 4515760 N; elevation is about 350 m (1148 ft); USGS map = Del Loma, CA, 1982 (no section lines); land ownership is Federal (Trinity National Forest, Big Bar Ranger District); and precision = S.

#11 (95000112) California, Trinity County, **near Dog Run Spring**. 1978 [April] 13. Two specimens (Roth 979). Month is April (not March); "near" is presumed to be within 150 feet of spring; UTM (for spring) are 489700 E and 4499960 N; elevation (exact at spring) is 1500 m (4921 feet); USGS map = Junction City, CA, 1982; land ownership is Federal (Trinity National Forest, Hayfork Ranger District); and precision = S.

#12 (95000029) California, Trinity County, **trail east of Del Loma**. 1978 March 13. One specimen (Roth 952). UTM are about 472100-472200 E and 4513930 N; elevation is 360-420 m (1181-1378 ft); USGS map = Del Loma, CA, 1982; land is probably Federal (Trinity National Forest, Big Bar Ranger District) but part of trail appears to cross private land; and "below" could be anywhere along 600 feet of trail, so precision = M (not S).

#13 (95000111) California, Humboldt County, **5.5 miles south of Weitchpec**, talus slope below road. 1978 March 13. One specimen (Roth 956). Distance is presumed to be road miles via California Route 96; although "5.5 miles" could be an artificially precise translation of 5½ miles, precision is presumed in estimating UTM as about

442670 E and 4552550 N, elevation is about 183 m (600 ft); USGS map = Hoopa, CA, 1979; land ownership is Hoopa Valley Indian Reservation; and precision = M.

#14 (95000117) California, Trinity County, **Limestone Creek**, in section 30, T. [33] N, R. 11 W. 1978 April 13. Three specimens (Roth 976). Location is in T. 33 N (not T. 4 N); there are no roads near Limestone Creek in section 30 (could be a mistake for section 31); UTM for center of section 30 are 487000 E and 4503000 N; rough range possible for elevation is 1020-1300 m (3346-4265 feet); USGS map = Hayfork Bally, CA, 1982; land is Federal (Trinity National Forest, Hayfork Ranger District); and precision = M.

#15 (95000033) California, Trinity County, **Natural Bridge**. 1978 April 14. Number of specimens not known (Roth 977). Site is presumed to be within 150 feet of the Natural Bridge over the stream in Bridge Gulch; UTM are 491350 E and 4482490 N; elevation is about 860 m (2821 feet); USGS map = Dubakella Mountain, CA, 1981; land ownership is Federal (Trinity National Forest, Hayfork Ranger District); and precision = S.

#16 (95000040) California, Trinity County, **Barker Creek** in section 16, T. [32] N, R. 11 W. 1978 April 15. Three specimens (Roth 978). This location is in Township 32 N (not T. 3 N nor T. 31 N); there is only a jeep road extending up into section 16 (site could be in section 21 or 28); rough UTM (for section 16) are 490000 E and 4497000 N; rough elevation range is 940-1100 m (3084-3609 feet); USGS map = Hayfork Summit, CA, 1982; land is private (or Federal if in section 21 or 28); and precision = M.

#17 (95000106) California, Trinity, **one mile south of Hyampom**. 1978 April 15. One specimen (Roth 975). Location is more likely in section 25 (not 36) of T. 3 N, R. 6 E, because there is no road along the river in section 36; rough UTM (for southern part of section 25) are 462000 E and 4495000 N; rough elevation is 400 m (1312 feet); USGS map = Hyampom, CA, 1982; land ownership is possibly private or more likely Federal (Trinity National Forest, Hayfork Ranger District); and precision = M.

#18 (95000050) California, Trinity County, unnamed **tributary to Packers Creek** at Forest Service road 4N16, in SW/4 of NE/4 of section 36, T. 33 N, R. 12 W. 1980 September 1. Five specimens (Roth 1209). UTM at stream crossing are 485780 E and 4501900 N; elevation is 1270 m (4167 feet); USGS map = Hayfork Bally, CA, 1982; land is Federal (Trinity National Forest, Hayfork Ranger District); and precision = S.

#19 (95000108) California, Trinity County, **0.5 road mile east of Del Loma**, Dougfir forest at east edge of limestone slide north of California Route 299, in NE/4 of SE/4 of section 25, T. 5 N, R. 7 E. 1980 October 25. One specimen (Roth 1222). This location is southeast (not east) of Del Loma; UTM are about 472300 E and

4513600 N; elevation is about 360 m (1181 ft); USGS map = Del Loma, CA, 1982 (no section lines); land is Federal (Trinity National Forest, Big Bar Ranger District); and precision = S.

#20 (95000031) California, Trinity County, **trail end east of Del Loma**. 1980 or 1981. Two shell fragments (Roth unnumbered). UTM are 472250 E and 4513980 N; elevation is 440 m (1444 ft); USGS map = Del Loma, CA, 1982 (no section lines); land ownership is Federal (Trinity National Forest, Big Bar Ranger District); and precision = S.

#21 (95000048) California, Trinity County, **3.9 miles west of Trinity River bridge** at Big Bar, north side of California Route 299, rockslide. 1981 April 28. Three specimens and fragments (Roth 1232). Two examples of *Prophysaon dubium* also found here (Roth and Pressley, 1983); UTM are about 474500 E and 4512670 N; elevation is 370 meters (1214 feet); USGS map = Del Loma, CA, 1982 (no section lines); land is Federal (Trinity National Forest, Big Bar Ranger District); and precision = M (not S because a 1% error for 3.9 miles of straight road is 205 feet, and California 299 is not straight).

#22 (95000107) California, Trinity County, **Bidden Creek** near Forest Service road 4N47 in SE/4 of section 19, T. 4 N, R. 8 E. 1981 May 27. Two specimens (Roth 1238b). Found on hillside roughly 50 m (164 ft) north of road and 100 m (328 ft) east of stream, and east of study plot of Roth and Pressley (1986 and personal communication), therefore this location should be in NW/4 of SE/4 of SE/4 of section 19; UTM are about 473710 E and 4505600 N; elevation is about 975 meters (3200 feet); USGS map = Big Bar, CA, 1982; land ownership is private; and precision = S.

#23 (not in Known Sites database) California, Siskiyou County, **"Shotgun" Timber Sale, unit #38**, one site in SE/4 of NW/4 of section 33, 10 N, R. 8 E, Humboldt Meridian. 1998 November 12. One shell and 2 live snails (sent to Barry Roth). Cutbank alongside spur road 10N19B on north-facing slope at 0.25 mile from road 10N19, roughly a half km east of Hotelling Gulch and 2 km south of South Fork of Salmon River. An incidental sighting for which UTM are about 477200 E and 4563160 N, the latlongs are about 123.27197E W and 41.22137E N, and elevation is about 823 m (2700 ft). USGS map = Youngs Peak, CA, 1979 (no section lines); land ownership is Federal (Klamath National Forest, Salmon River Ranger District); and precision = S.

#24 (not in Known Sites database) California, Siskiyou County, **"Shotgun" Timber Sale, unit #35**, 2 sites (Sample Areas #2 and #3) near center of section 35, T. 10 N, R. 8 E, Humboldt Meridian. 1998 November 16. Two shells (one from each site). North-facing slope about 1 km south of South Fork of Salmon River, and about a half km east of Knownothing Creek. For Sample Area #2 the UTM are about 475860 E

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and 4564650 N, latlongs are about 123.28802E W and 41.23480E N, and elevation is about 585 m (1920 ft). For Sample Area #3 the UTM are about 475730 E and 4564550 N, the latlongs are about 123.28951E W and 41.23387E N, and elevation is about 658 m (2160 ft). USGS map = Youngs Peak, CA, 1979 (no section lines); land ownership is Federal (Klamath National Forest, Salmon River Ranger District); and precision = S.

#25 (not in Known Sites database) California, Siskiyou County, **"Shotgun" Timber Sale, unit #36**, ubiquitous (present at all 21 Sample Areas plus some Point Searches) in west half of section 28 and east half of section 29, T. 10 N, R. 8 E, Humboldt Meridian. 1998 November 17-18. 25 shells and 15 live snails (shells retained). An area of 44 hectares (108 acres) on a generally north-facing slope roughly 1 km east of Knownothing Creek and a half km south of South Fork of Salmon River. For Sample Area #18 (somewhat central within the unit) the UTM are about 476550 E and 4564720 N, the latlongs are about 123.27984E W and 41.23535E N, and elevation is about 543 m (1780 ft). USGS map = Youngs Peak, CA, 1979 (no section lines); land ownership is Federal (Klamath National Forest, Salmon River Ranger District); and precision = S (for SA #18).

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SECTION NO. 6

Hemphillia burringtoni	**Burrington Jumping-slug**
Hemphillia glandulosa	**Warty Jumping-slug**
Hemphillia malonei	**Malone Jumping-slug**
Hemphillia pantherina	**Panther Jumping-slug**

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Management Recommendations for Four Species of the Genus Hemphillia

V. 2.0

Burrington Jumping-slug (***Hemphillia burringtoni)***
Warty Jumping-slug (***Hemphillia glandulosa***)
Malone Jumping-slug (***Hemphillia malonei***)
Panther Jumping-slug (***Hemphillia pantherina***)

by

Thomas E. Burke

Wenatchee National Forest
Entiat Ranger District

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MANAGEMENT RECOMMENDATIONS
FOR
FOUR JUMPING-SLUGS (*HEMPHILLIA* SP.)

EXECUTIVE SUMMARY

Species:

Hemphillia burringtoni	(Pilsbry 1948)	Burrington Jumping-slug
Hemphillia glandulosa	(Binney & Binney 1872)	Warty Jumping-slug
Hemphillia malonei	(Pilsbry 1917)	Malone Jumping-slug
Hemphillia pantherina	(Branson 1975)	Panther Jumping-slug

Taxonomic Group: Mollusks (Phylum Mollusca: Class Gastropoda)
Family: Arionidae (*Hemphillia*)

ROD Components: Survey and Manage Strategies 1 and 2.

Other Management Status:

- *Hemphillia burringtoni* is on the WM list and is a BLM Tracking species (BLMT) for Washington.
- *Hemphillia glandulosa* is on the ONHP list 2*, WM, it is a BLM assessment species (BLMA) in Oregon and a BLMT in Washington.
- Hemphillia malonei is on the ONHP list 1, WM, BLMT in Washington, and BLMS in Oregon.
- *Hemphillia pantherina* is a WM species and a BLM tracking species for Washington.

* Oregon Natural Heritage Program "list 1" species are critically imperiled because of extreme rarity or because they are especially vulnerable to extinction or extirpation, (typically with 5 or fewer known occurrences): ONHP list 2 species are imperiled because of rarity or because other factors make them very vulnerable to extinction or extirpation (typically with 6-20 known occurrences): ONHP list 3 species are rare, uncommon or threatened but not immediately imperiled (typically with 21-100 known occurrences).

Range:

Hemphillia burringtoni - Throughout the Olympic Peninsula, Washington, possibly including the foothills of the Cascades and south to the Coast Range of northwestern Oregon.
Hemphillia glandulosa - Western Cascade Range to the Pacific Coast from northwestern Oregon to British Columbia, Canada.
Hemphillia malonei - Mount Hood, Oregon, northward through the Columbia Gorge and into the southwestern Cascades of Washington.

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Hemphillia pantherina - Known from a single site near the Lewis River, Skamania County, Washington. It should be suspected throughout the Cascade Range of western Washington from the Snoqaulmie watershed south.

Specific Habitat: This group of 4 slugs inhabits moist, conifer forest habitats. Although often occurring within riparian areas and possibly confined to the riparian in some dry landscapes, these species are not generally riparian obligates. Since they all occupy similar habitats, with few exceptions, one species is as likely to be found as another where their ranges overlap. Therefore, all four, as well as other survey and manage species, should generally be included in any search pattern within their known or suspected ranges.

Some specific microsite characteristics for the individual species include:

Hemphillia burringtoni - generally conifer logs and/or heavy ground cover of low vegetation, litter, and debris.

Hemphillia glandulosa - same as *H. burringtoni*

Hemphillia malonei - same as *H. burringtoni*, but may be found at higher elevations if sufficient ground cover is available.

Hemphillia pantherina - Assumed to be the same as for other Hemphillia; however, the only recorded site for *H. pantherina* is near a creek crossing. It is not known whether this species is more strongly associated with riparian or if this is merely coincidental.

Threats: Primary threats to this group of species are habitat destruction from forest management, conversion for agricultural, urbanization and other uses, and fire. Natural threats may include vertebrate and invertebrate predators (i.e., predatory snails, and beetles, especially in locally restricted areas).

Currently *Hemphillia pantherina* is the least known of this group, and loss of the one known population would mean extinction as far as is currently known of that species.

The other three species in this group are more widespread and have been found more recently, although their populations are widely disjunct, and they may be difficult to find.

Management Recommendations:

- Protect the existing occupied sites from activities that would alter microsite characteristics, including areas large enough to moderate fluctuations in humidity, temperature, and other environmental characteristics.

- Protect cover by preserving and recruiting dead and downed woody debris. Within habitats for these species a greater abundance of large woody debris will be necessary than that prescribed in the ROD, and the quantity needed is yet to be determined (ROD pg. C-40, item A).

- Protect occupied rockslides and talus areas from road construction, quarrying, and other activities.

- Maintain natural canopy closure of trees within the Habitat Area to moderate fluctuations of temperature and humidity on the site.

- Maintain the hardwood tree component (i.e., maples, cottonwood, red alder, aspen) and native plant diversity to provide a constant supply of logs, leaves, and leaf mold.

- Protect known occupied riparian sites by maintaining riparian areas according to ROD guidance (pgs. C-30-C-38) and, if necessary, increasing Riparian Reserve widths.

- Protect known occupied sites from adverse effects of fire.

- Protect Habitat Areas from activities that would significantly compact the soil or disturb the litter layer.

Information Needs:

What is the specific range of each of these species?
What is the range of habitat conditions tolerated by each species?
What are the specific biological and physical attributes of the habitat:
- Plant associations;
- Specific plant species required/used;
- Specific foods;
- Amount of large woody debris desired;
- Optimum forest crown cover to maintain desired conditions;
- Other stand structure and components;
- Soil types, geology;
- Temperature, humidity.

What are the stand characteristics (canopy cover, plant species, stand age, large woody debris, litter, and duff, etc.) required to support the conditions required?

How do the required stand characteristics vary under different circumstances (elevation, slope, aspect, etc.)?

What stand size is required to provide sufficient area of suitable habitat?

How long is required for recolonization of a site by individuals from adjacent populations?

Monitoring of known sites is needed to:

- track trends in populations (numbers, density and distribution), reproduction, quantity and quality of habitats;

- determine impacts on habitats and populations from management activities, natural disturbances, and vegetative succession;
- maintain a database to document trends in populations and habitats.

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MANAGEMENT RECOMMENDATIONS FOR FOUR JUMPING-SLUGS (*HEMPHILLIA* SP.)

Natural history and current species situation accounts for each of the four species addressed in this document are described separately in the following sections I and II. Management goals, habitat management, information, and monitoring needs sections III-V are combined for all species and follow these accounts.

I. NATURAL HISTORY

General information for genus *Hemphillia*

Hemphillia are a unique group of slugs endemic to the Pacific Northwest. Evolutionarily, they appear between snails and slugs, retaining the visceral mass in a raised hump under the mantle, and a shell plate that is not completely enclosed as it is in all other slug species of western North America. This shell is visible through a slit in the back of the mantle. The pneumostome (breathing pore) is in the right side of the mantle about or slightly posterior to the middle. The tail is relatively narrow and a little tapered, and there is a caudal fossa (mucous pit) near the tip where the pedal furrows converge. Over the caucal pit is a triangular flap of tissue, referred to as the "horn", which is developed to different degrees in the different species.

The common name is derived from their habit of flipping their tails and writhing when disturbed, causing them to flop around like a fish out of water.

Of 7 described jumping slugs, 4 of them are on the survey and manage list. Branson (1975) provides the best key currently available for identifying species of *Hemphillia*.

Species: *Hemphillia burringtoni* (Keeled Jumping-slug)

A. Taxonomic/Nomenclatural History

Family: Arionidae
Subfamily: Binneyinae
Hemphillia burringtoni Pilsbry, 1948

Pilsbry (1948) described *Hemphillia glandulosa burringtoni* as a new subspecies. Branson (1972) elevated it to full species based on, ". . . consistent differences of genitalia and external pigmentation patterns."

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B. Species Description

1. Morphology

The following description is condensed from Pilsbry (1948) and Branson (1972): *H. burringtoni* is a relatively small slug, 8-20 mm long. Its body is depressed under the visceral pouch, then the tail is raised into a prominent keel. The head and tentacles are black. The mantle lacks the distinct papillae found on the very similar *H. glandulosa*, and is speckled with gray and black. There is a row of distinct gray to black dots along the sides just above the pedal furrows. Below the pouch, the body is marked posteriorly by 7 to 9 broad, dark gray diagonal bands. The penial stimulator of *H. burringtoni* is smooth within while that of *H. glandulosa* is rugose (wrinkled).

The following direct quotes are included in the likelihood that they may be helpful to personnel attempting to distinguish between slugs of this genus. All of these quotes refer to *H. burringtoni* or its relationship to *H. glandulosa*.

"The body is depressed under the pouch, raising behind it to form a high compressed keel; the horn over the caudal pit is lacking or very small. Visceral pouch nearly smooth; penial stimulator smooth within" (Branson 1975). In an earlier description Branson (1972) said, "Posteriorly, the moderately developed hornlike protuberance above the caudal mucous gland is bluntly rounded behind, but is rather triangular in lateral view."

"Externally it resembles *H. glandulosa* except that there is no trace of papillae on the mantle, which is smooth. The spaced oblique lines on the sides of the foot terminate in gray dots above the pedal groove, and back of the middle these lines are somewhat pigmented. On the elevated tail they break into a coarse network and are pigmented" (Pilsbry 1948).

2. Reproductive Biology

Nearly all of the terrestrial gastropods in the Pacific Northwest, including the *Hephillia*, are hermaphroditic, having both male and female organs. Self-fertilization has been demonstrated in some species, although cross-fertilization is probably the norm. Bayne (1973) discussed problems encountered with self- and cross-fertilization in Pulmonates, and the dominance of allosperms (sperm from another) over autosperms (sperm from oneself). *Hemphillia* are oviparous (egg layers); the clutches are generally small, consisting of only a few eggs (Burke, personal observations).

3. Ecology

Hemphillia burringtoni is a species of low to mid elevation rain forests. Particular foods and cover types are not documented, but most *Hemphillia* are usually found within or under rotting logs, or forest floor litter, apparently feeding on decaying wood or vegetation or organisms associated with that decaying matter. Thus these slugs assist in decomposition of forest floor debris, thereby contributing to organic matter in the soil. The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate that allows viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, snails and slugs represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active.

Specific enemies of the jumping-slugs have not been documented, but as with other mollusks, they are preyed upon by a variety of predators. Their unique "jumping" habit is assumed to be an adaptation for defense against some type or types of predators, the specifics of which were not found documented.

C. Range, Known Sites

H. burringtoni is known from the Olympic Peninsula, Washington, south to the Coast Range of northwestern Oregon. The type locality is Rialto Beach, Olympic National Park, just north of the Quillayute River mouth, Clallam County, Washington (H. B. Baker 1929; cited in Pilsbry 1948).

Branson (1977) reported 9 specimens from 7 locations on the Olympic Peninsula in Clallam, Jefferson, Mason, and Grays Harbor counties, and 1 from Bush State Park, Pacific County, Washington. Branson and Branson (1984) reported a probable immature specimen from Clatsop (Tillamook) County, Oregon.

D. Habitat Characteristics and Species Abundance

D-1. Habitat - The general habitat for all Hemphillia species in this document is moist forest dominated by conifers but with a moderate hardwood component. The forest floor is moist but not wet or saturated. Large woody debris, both conifer and hardwood, is abundant. Logs of decomposition class 2-4 are probably most often used. Litter and duff layers are deep and generally continuous. Low vegetation may be patchy and consist of sword ferns and other plants of cool shaded forests.

Specific circumstances other than those described above may also provide suitable habitat for some of this group of gastropods. Some species are known to occur in talus or riparian habitats where suitable microsite conditions apparently may occur without all of the other recognized components.

Hemphillia burringtoni inhabits rainforests and other wet forest areas in western Washington to northwestern Oregon from sea level to at least 1050 meters (3445 feet) elevation, the point at which Branson (1977) called "transition zone." Habitat descriptions are not extensive, but they imply general rain forest, or other moist to wet forest conditions with heavy shading or vegetative cover, or (as with many gastropods) talus. Logs and/or other woody debris are important to the *Hemphillia*.

Branson (1977 & 1984) found this species in dense rain forest including hemlock, spruce, western red cedar, pines, ferns and mosses, sometimes associated with fallen logs, talus, and/or shrubs. Branson (1972 & 1977) reported it from elevations ranging from 166 to 1050 meters (545 to 3435 feet), in rain forests, with heavy Pacific dogwood growth in one site, in talus at one site, and with ferns and fallen logs.

USDA, Forest Service, and USDI, Bureau of Land Management (1974: J2-347) says, "Species is a riparian associate." This may be true in the sense that moist riparian forests support many snails and slugs, but no references found indicated that *H. burringtoni* has any particular affinity to riparian habitat over other moist forest conditions. Frest and Johannes (1993) called it an "Old growth and riparian associate . . .", which better aligns with the meager descriptions of the locations by Branson (op cit).

D-2. Species Abundance - *Hemphillia burringtoni* is a local endemic of western Washington and possibly northwestern Oregon, but it currently appears to be rare within that range. It has been reported from 10 sites. Pilsbry (1948) reported it only from the type locality. Branson (1977) found 9 specimens at 7 of 269 sites surveyed on the Olympic Peninsula, plus 1 specimen from near Willapa Bay. In their surveys of the Oregon Cascades and Coast Range, Branson and Branson (1984) found one specimen that may have been this species. Frest and Johannes (1993) said they had not found it at their Washington sites in 1986 through 1991.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed Under Survey and Manage Standard and Guideline

"The rating for the species is based on the possible reduction from its historic distribution, the lack of knowledge of its current status, and the lack of specific protection in the Olympic AMA" (USDA, Forest Service, and USDI, Bureau of Land Management, 1974: J2-347).

The Burrington Jumping-slug is a rare local endemic species of western Washington and possibly northwestern Oregon. Its habitat is in rain forests at low to moderately high elevations. These habitats have been reduced by timber management within its range.

B. Major Habitat and Viability Considerations

Habitat of the Burrington jumping-slug is in rainforests and riparian habitats, which have been greatly reduced on the Olympic Peninsula. Some of the habitat for this species is in the Olympic National Park and may be protected there. Other habitat may be managed as Late-Successional Reserve (LSR) or Adaptive Management Area (AMA) on the Olympic National Forest. Since AMAs are to be managed experimentally, to plan for that management it will be necessary to know whether this species occurs there and what habitat components are necessary to support the biotic cummunity needed to maintain its viability. While LSRs are more likely to remain undisturbed by human activities (other than recreation), early successional stands within these areas may still be under management to bring them into late-successional condition. The same conditions apply in these cases as do for the AMAs. The Olympic National Forest site is also a heavily used recreation area, as well as the advertised Mt. Walker Observation Area.

Occurrence and distribution needs to be clarified for *H. burringtoni* and *H. glandulosa*. While both are species of concern, there may be confusion over distribution based on past species or subspecies determinations. In order to understand population trends, species status, and habitat relationships, it will be necessary to understand the differences and similarities between ranges, habitats, ecology, and biology.

As populations become more scattered or less dense, chances of crossbreeding decrease, causing an expected corresponding increase in homozygosity (sameness of corresponding genes between the two sets of chromosomes). In general, the more heterozygous (differing between genes of the two sets of chromosomes) a species or population is, the more adaptable to change or adverse circumstances it will be. Therefore, loss of heterozygosity in a population is considered deleterious to its survival, and the smaller the population, the less likely it will be for it to recover its genetic diversity.

C. Threats to the Species

Threats to Burrington's jumping slug include loss of habitat through timber harvest, and development for housing, recreation, and other uses. Habitat fragmentation reduces sizes of populations; reduction in habitat quality reduces density of populations.

Olympic National Park supports much of the currently known population of this species, 7 of 10 known sites. These population segments may be secure, but what percentage of the historic range of the species occurs within the Park is not known. Based on the much broader range of the species, it is speculated that the populations within the park are a relatively small portion of the total. The site on the Olympic National Forest is near the boundary between an AMA and an LSR. These management areas may or may not protect the habitat as discussed under "major habitat and viability considerations," above. Evaluation is needed to determine the distribution of the species throughout its range, and the number and distribution of secure potential refugia.

D. Distribution Relative to Land Allocations

Most known sites (7 of 10) are in the Olympic National Park. One known site is on the Olympic National Forest in AMA or LSR, and in a heavily used recreation view area. One site is on the Quinault Indian Reservation, and one is in a State Park. These were discussed in some detail, above.

Species: *Hemphillia glandulosa* (Warty Jumping-slug)

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Family: Arionidae
Subfamily: Binneyinae
Hemphillia glandulosa Bland & Binney, 1872

B. Species Description

1. Morphology

As with all *Hemphillia*, this species has a distinct visceral hump covered by the mantle, and the shell is visible through a slit in the back of the mantle. There is an obvious caudal mucous pit at the posterior confluence of the pedal furrows.

The following description is condensed from Pilsbry (1948) and Branson (1972): It is a rather small slug, 12 to 30 mm. long. As with *H. burringtoni*, the body is depressed under the pouch, then the tail is raised into a prominent keel. The most distingushing feature of *H. glandulosa* is the numerous distinct papillae, which cover the mantle. The color is whitish with dark markings, the head and tentacles being dark blueish with white sides below. The mantle also dark, but light on the edges and posteriorly. The inside of the penial stimulator is wrinkled.

The following comments and quotes are included in the liklihood that they may be helpful to personnel attempting to distinguish between slugs of this genus. All of these quotes refer to *H. glandulosa* or its relationship to *H. burringtoni*.

Hemphillia glandulosa is similar in appearance to *H. burringtoni* except that its mantle is covered with distinct papillae. Branson (1972) showed that the penial stimulator of *H. burringtoni* is smooth within, while that of *H. glandulosa* is rugose (wrinkled).

The body is depressed under the pouch, raising behind it to form a high compressed keel. The horn over the tail is lacking or very small. "Visceral pouch bearing numerous papillae; penial stimulator rugose within" (Branson 1975). The preserved animal is 10 to 30 mm. long (Pilsbry 1948). Pilsbry's description varies from Branson's in saying, ". . . keel declining and terminating in a prominent horn-like process at the end." The type description of Bland and Binney, quoted by Pilsbry, also states, "Caudal process very large, triangular in profile, dark brown with a few coarse granulations." It has a papillose mantle, and a rugose stimulator in contrast to the smooth ones of *H. burringtoni* (Branson 1972).

2. Reproductive Biology

See discussion under *Hemphillia burringtoni*, above.

3. Ecology

Hemphillia glandulosa is found in relatively moist, generally low to middle elevation, undisturbed coniferous forests or riparian areas (Frest and Johannes 1993). Particular foods and cover types are not documented, but most *Hemphillia* are usually found within or under rotting logs, or forest floor litter, apparently feeding on decaying wood or vegetation or organisms associated with that decaying matter. Thus these slugs assist in decomposition of forest floor debris, thereby contributing to organic matter in the soil. The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate which allows viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, snails and slugs represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active. Specific enemies of the jumping-slugs have not been documented but, as with other mollusks, they are preyed upon by a variety of predators. Their unique "jumping" habit is assumed to be an adaptation for defense against some type or types of predators, the specifics of which were not found documented.

C. Range, Known Sites

The range of *H. glandulosa* is from Multnomah and Clatsop counties, Oregon, to British Columbia, in the western Cascade Range and west to the Pacific Coast. Washington locations included: King, Pierce, Thurston, Lewis, Skamania, Clallam, Grays Harbor, Pacific and possibly Whatcom counties.

Branson (1972) says *H. glandulosa*, "occupies mainland Washington west of the Cascades and adjacent British Columbia westward to the Olympic and Gray Wolf mountains and southward to northern Oregon." He did not report it in any of his surveys of the Washington Olympic or Cascade Range (1977, 1980) or Oregon Cascades and Coast Range (Branson and Branson 1984).

Pilsbry (1948) cites 8 locations from Washington and Oregon and 2 from British Columbia. Oregon: Astoria & Portland; Washington: Tacoma, Olympia, Grays Harbor, Point Ellis, Pacific County, Neah Bay, 10 miles north of Hoquiam; British Columbia: 3 miles up Naniamo River, and on the Corvichan River.

Burke (personal notes) has found it in the Hoh River Watershed, Olympic National Park, Jefferson, County, Washington. Other sites were being reported as 1998 fall surveys progressed. New sites extend the range as far south as the Waldport Ranger District, Siuslaw National Forest in the Oregon Coast Range, the St.Helens Ranger District, Gifford Pinchot National Forest in the southwestern Cascades of Washington, and several new sites on the Olympic National Forest.

D. Habitat Characteristics and Species Abundance

D-1. Habitat - *Hemphillia glandulosa* inhabits relatively moist and undisturbed coniferous forest, generally at low to middle elevations (Frest and Johannes 1993). Some sites may be riparian (USDA, Forest Service, and USDI, Bureau of Land Management (1974: J2-347)). It is generally found under forest floor litter or debris and on or under logs. During the fall rainy season, Olympic National Forest surveyors find them in rain forests on the forest floor litter.

G. W. Taylor found it in British Columbia under ferns, and A. W. Hanham found it, ". . . among dead leaves of thickets in pastures" (Pilsbry 1948).

D-2. Abundance - This species is not abundant. Branson did not record it in any of his surveys, the Washington Cascades (1980), The Olympic Peninsula (1977), or the Oregon Cascades and Coast Range (Branson and Branson 1984). Frest and Johannes (1993) said, "We have not seen this species at our sites." Burke has records of it from 2 locations. Pilsbry (1948) lists 8 locations from Washington and Oregon and 2 from British Columbia. One specimen was

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recorded from each site for which data is available, except 2 were found at one site.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed Under Survey and Manage Standard and Guideline

The rating is based on the large historic range reduction, uncertainty about the species current status, and lack of knowledge of how well existing locations are protected by the features of Alternative 9 (USDA, Forest Service, and USDI, Bureau of Land Management (1974: J2-348)).

The species has apparently been extirpated from many of the old sites (Pilsbry 1948; Frest and Johannes 1993).

B. Major Habitat and Viability Considerations

Undisturbed moist forest situations in which this species is found have been reduced by logging, agriculture, and urban development. "Many of the old sites were in the Willapa Hills and are probably extirpated, as this area has been almost completely lumbered. Most other localities were from areas now strongly urbanized" (Frest and Johannes 1993).

Genetic diversity in small or low density populations should also be of concern.

C. Threats to the Species

Threats to *H. glandulosa* include loss or fragmentation of habitat, and modification of habitat conditions, so that the species is no longer supported. A major concern is that there are so few recent observations that populations are not well known or documented. While there are likely more sites on which they occur, surveys are needed to determine where and how extensive their populations are, and what their actual habitat requirements are, before land management inadvertently degrades the habitat on those existing unknown sites.

D. Distribution Relative to Land Allocations

Some old sites were in Olympic National Park and Olympic National Forest (Frest and Johannes 1993), and it has recently been rediscovered on lands administered by those agencies. It has also recently been found on matrix lands on the Gifford Pinchot and Siuslaw National Forests in units being surveyed for planned land management. It probably also occurs on the Mount Baker-Snoqualmie National Forest, possibly in the Snoqualmie Pass AMA, and other National Forests in Washington. However, where it may occur on those lands is not yet known.

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Species: ***Hemphillia malonei*** **(Malone Jumping-slug)**

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Family: Arionidae
Subfamily: Binneyinae
Hemphillia malonei Pilsbry (1917)

Pilsbry (1948) considered this a "doubtful" species, most likely *H. camelus*. However, Kozloff and Vance (1958) showed it to be a distinct species.

B. Species Description

1. Morphology

Hemphillia malonei reaches a length of up to 6 cm. The tail is laterally compressed but is not elevated into a high keel. The ground color is usually light tan to buff; the tentacles are darker. The anterior half of the mantale has a few scattered, small, black spots. The sides are light colored, with dark gray motling beginning under the mantle and increasing in density posteriorly, so the sides of the tail behind the mantle are rather dark gray. The tail has a light colored, mid-dorsal line that is usually brighter than the ground color.

Kozloff and Vance (1958) said that *H. malonei* is closely related to *H. camelus* and can probably not be separated on the basis of form and pigmentation. However, based on differences in anatomy of the reproductive system and the alimentary tract, the two species are distinct. However, the ranges of these two jumping-slugs do not overlap.

"Body behind pouch neither depressed nor produced into a keel . . . . Color ashy-gray, bluish-black to black . . . . Tail lacking a conspicuous horn-like protuberance above meeting of pedal groves . . . . Sperm duct opening within epiphallus into penis on side near base of verge attachment; penial retractor attachment partially to upper end of penis, partially to epiphallus" (Branson 1975). *H. camelus* for comparison has "Sperm duct opening within epiphallus into penis near end of verge; penial retractor attachment to epiphallus only" (Branson, op. cit.).

Largest specimens 60 mm long when extended. Posterior half of tail somewhat keeled above. Normally there is no caudal horn, but some specimens had such a projection, although not conspicuous (Kozloff and Vance 1958).

Pilsbry (1948) says, "The general color is dusky drab, becoming blackish-brown on the tail. There are a few small black spots along the sides of the mantle, which has a very large opening exposing the shell. Pneumostome is about midway of the mantle. Behind the mantle there is a short median impressed line flanked by obliquely decurrent lines; followed posteriorly by irregular, coarse granulation, the end of the tail then becoming carinate. The pedal furrows rise behind, as in *H. camelus*, and there is no horn above their junction, and no specialized caudal mucous pore . . . . The mantle is smooth. Total length preserved in formaldehyde 33 mm.; length of the mantle about 16 mm . . . length of the shell about 10.5 mm."

2. Reproductive Biology

See discussion under *Hemphillia burringtoni*, above.

3. Ecology

Nothing could be found in the literature specific to the ecology of *Hemphillia malonei*. It is found in moist forests often near wet areas, over a broad elevational range (see Habitat, below). We have found it on skunk cabbage, and on the underside of bigleaf maple bark. It appears to prefer wet areas but is also found in moist mature or old growth forests.

Particular foods and cover types are not documented, but most *Hemphillia* are usually found within or under rotting logs, or in forest floor litter, apparently feeding on decaying wood or vegetation or organisms associated with that decaying matter. Thus these slugs assist in decomposition of forest floor debris, thereby contributing to organic matter in the soil. The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate which allows viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, snails and slugs represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active. Specific enemies of the jumping-slugs have not been documented but, as with other mollusks, they are preyed upon by a variety of predators. Their unique "jumping" habit is assumed to be an adaptation for defense against some type or types of predators, the specifics of which were not found documented.

C. Range, Known Sites

Malone's jumping slug is endemic to Mount Hood and the Columbia Gorge, in Clackamas, Multnomah, Hood River counties, Oregon, and at least Skamania and probably Clark counties, Washington. Recent range extentions have found it in the Salem BLM District and Siuslaw National Forest, farther south in Oregon than previously known.

Branson and Branson (1984) found it in the Columbia Gorge and Mount Hood regions of Oregon, and reported previous records from Clackamas, Multnomah, and Hood River Counties, Oregon. Type specimen from "Tawney's Hotel, on the Salmon River, 12 miles from Mt. Hood, elevation 1600 feet (J. G. Malone . . .)" (Pilsbry 1948).

It is found on Larch Mountain, Multnomah County, in the Columbia Gorge in Hood River County, and Clackamas County, Oregon. It ". . . could also extend into Washington (particularly Clark and Skamania counties.)" (Frest and Johannes 1993).

In the past two years (1997-98) it has been found north of the Columbia Gorge in Washington, and on the Salem BLM District in Oregon.

D. Habitat Characteristics and Species Abundance

D-1. Habitat - Habitat of *H. malonei* is best summarized by Frest and Johannes (1995):

"Generally in partly open, but uncut forest, at low to high elevations . . . , typically in rather moist Douglas-fir forest with diverse forbs and well-developed litter. Moist valley, ravine, gorge, or talus sites are preferred, i.e., low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistent moisture is a *desideratum*."

Other observations indicate that it may indeed prefer wet areas, such as seeps springs and wet riparian habitats, but it is also found in moist old growth forests. It has also been found in a recently managed stand in which the hardwoods were left, the ground was wet, and the site had not been burned. The population trend at that site would be of interest. Elevational range of known occurrences is from near sea level to about 1200 meters (4000 feet), but suitable habitat at any elevation should be considered potential.

USDA, Forest Service, and USDI, Bureau of Land Management (1974: J2-349) under "Natural History" said, "Habitat is moist forest, not necessarily riparian areas." It is found under rotting logs, from approximately 60-1200 meters (200-4000 feet) elevation (Kozloff and Vance 1958). Branson and Branson (1984) found it at 180-1372 meters (590-4500 ft.) elevation, in Douglas-fir to subalpine fir forests, among decaying wood, wood sorrel, ferns, and mosses. It is "Generally in open but uncut forest, at low to high elevations . . . . This species may co-occur with the Larch Mountain salamander . . ." (Frest and Johannes 1993). We have also found it on skunk cabbage and on the underside of bigleaf maple bark lying on the ground (Burke, personal observations).

D-2. Abundance - Prior to 1997, total of 43 specimens of *H. malonei* had been reported from 6 locations. Malone originally collected 3 specimens from the type locality (Pilsbry 1948). Kozloff and Vance (1958) worked with 28 specimens from 2 locations, and Branson and Branson (1984) reported 12 specimens from 3 sites. Frest and Johannes (1995) said it was recollected in 1990, but gave no details.

In the last two years additional sites have been found for *H. malonei*. It was found on private land in the Columbia Gorge, Skamania County, Washington, where six were collected. It has been found on the St.Helens and Cowlitz Valley Ranger Districts on the Gifford Pinchot National Forest in Washington. And, it has also been found in the Bull Run Watershed, and other locations on the Mount Hood National Forest, Clackamas County and on the Salem BLM District, Benton County, Oregon.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed Under Survey and Manage Standard and Guideline

Analysis under the EIS for the Northwest Forest Plan found a liklihood of this species becoming well distributed under Option 9, as 28%. It also determined a 28% chance of it being locally restricted, 25% that it would be restricted to refugia, and 18% that it would be extirpated. "The rating is based on the restricted range of the species and uncertainty about the possible effects of activities proposed in LSRs" (USDA, Forest Service, and USDI, Bureau of Land Management, 1974: J2-349).

The species is a local endemic of the Columbia River Gorge and vicinity, including the north side of Mount Hood, southwestward into the Salem District of BLM, and north into Washington (see "Range, Known Sites", above).

B. Major Habitat and Viability Considerations

Habitat is undisturbed moist to wet forest stands, ranging from the Columbia River Gorge on the river to the subalpine fir zone on Mount Hood southwest into the Salem BLM District, and northward at least to the Cowlitz River watershed. Undisturbed moist forest situations in which this species is found, are vulnerable to logging, recreation, and urban and road development. Much of the remaining habitat is probably in LSR or other withdrawn areas, but

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specific protection may still be needed since proposed management in the LSRs might alter the habitat enough to be unsuitable for this species.

Genetic diversity in populations of small size or low density should also be of concern.

C. Threats to the Species

Loss of habitat through timber harvest, recreation, urban development, and road construction are potential threats.

Speculation on additional existing occupied habitat and potential habitat is unconfirmed and occupied areas need to be determined. Without this knowledge, much of the existing habitat could be inadvertently degraded. Habitat fragmentation reducing populations and species density is a potential threat.

D. Distribution Relative to Land Allocations

Four of the known sites are on the Columbia Gorge National Scenic Area, the one in Washington being on private land and the three sites in Oregon on Federal land. Other sites include: one on the Mount Hood National Forest, in the lower Bull Run Watershed; at least one on BLM, Salem District; and 1 on private land. New sites discovered in 1998 are mainly from proposed project areas.

Part of the range of *H. malonei*, being in the Columbia Gorge and on the Mount Hood National Forest, may be in LSR. There may also be habitat within Congressionally Withdrawn and Administratively Withdrawn areas (USDA, Forest Service, and USDI, Bureau of Land Management, 1974: Federal Land Allocations Proposed under Alternative 9, Feb., 1994). However, new sites found during fall 1998 surveys are most likely in Matrix lands, proposed for management.

Species: *Hemphillia pantherina* (Panther Jumping-slug)

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Family: Arionidae
Subfamily: Binneyinae
Hemphillia pantherina Branson (1975)

Branson described this species from a single specimen collected during his survey of the Washington Cascade Range in 1973.

B. Species Description

1. Morphology

The body is depressed under the pouch, raising behind it to form a high compressed keel; mantle not covering posterior one-third of visceral pouch; tail with a large, distinct "horn" above meeting of pedal grooves (Branson 1975). Branson's preserved specimen measured 14.2 mm long.

The above characteristics should be sufficient to identify this slug, but its color, described by Branson and partially quoted here, is also unique. The head and tentacles are white dorsally, pale gray ventrally. The heavily granulose mantle is off-white and unmarked along the lower margins, but marbled on the dorsal two-thirds with dark stellate markings. The sides are white anteriorly, but the posterior half is marked by "26 large, cell-like granules outlined by black." Posteriorly it is "dusky" near the midline, "but the high keel is bold white."

2. Reproductive Biology

See discussion under *H. burringtoni*, above.

3. Ecology

The species was found beneath deep forest litter near a creek crossing on the Gifford Pinchot National Forest (Branson 1975). No other specific habitat or ecological information is available.

Particular foods and cover types are not documented, but most *Hemphillia* are usually found within or under rotting logs, or in forest floor litter, apparently feeding on decaying wood or vegetation or organisms associated with that decaying matter. Thus these slugs assist in decomposition of forest floor debris, thereby contributing to organic matter in the soil. The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate which allows viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, snails and slugs represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active. Specific enemies of the jumping-slugs have not been documented but, as with other mollusks, they are preyed upon by a variety of predators. Their unique "jumping" habit is assumed to be an

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adaptation for defense against some type or types of predators, the specifics of which were not found documented.

C. Range, Known Sites

H. pantherina is known from a single location in the Lewis River Drainage, Gifford Pinchot National Forest, Skamania County, Washington (Branson 1975). This species should be considered a potential find during surveys throughout the Cascade Range of western Washington. Type locality is given as Miller Creek crossing, Gifford Pinchot National Forest.

D. Habitat Characteristics and Species Abundance

D-1. Habitat - The type specimen was found under deep forest litter near a creek crossing (Branson 1975). Potential habitats include those typical for other *Hemphillia* species, under and inside of logs and other forest floor litter, and in talus, in moist forests and riparian areas.

D-2. Abundance - *H. pantherina* is likely the rarest of described gastropods in the Western United States. Branson (1975) described the species from a single specimen found in 1973. Dr. Timothy Pearce claims to have relocated it at the type locality (no number given), but it has not been found at any other location (Terrence Frest, personal communication).

II. CURRENT SPECIES SITUATION

A. Why Species is Listed Under Survey and Manage Standard and Guideline

The FEMAT analysis made the following (startling) conclusion about this species that was not even known to still survive when the analysis was done: 32% chance of becoming well destributed under option 9; 25% chance of being locally restricted; 22% chance of being restricted to refugia; and 22 % chance of being extirpated. The rating is based on lack of specific information about the species range, or locations, or the effect of the proposed action (USDA, Forest Service, and USDI, Bureau of Land Management, 1974: J2-351).

Only one specimen has been documented, although T. Frest has been told (by T. Pearce) that the species was found again at the type locality (Frest and Johannes 1996).

B. Major Habitat and Viability Considerations

The population appears to be very small and limited in distribution, being known from only one small area.

As with all small and/or scattered populations, genetic viability is of concern. H. pantherina may be a newly evolved species. Not having been found in other localities, we do not know whether or not it exists other than in the one vicinity. If a single population is the case, degradation of that habitat or other causes detrimental to the population may lead to extinction of the species.

C. Threats to the Species

Any site disturbance that alters the habitat characteristics within the vicinity of this population locality might be detrimental to the species survival.

D. Distribution Relative to Land Allocations

The type locality (only know site) is on the Gifford Pinchot National Forest and is near an LSR, although it is difficult to tell whether it is LSR or matrix.

III. MANAGEMENT GOALS AND OBJECTIVES

The following management goals and objectives apply to all species discussed in this document.

A. Management Goals for the Taxon

Management goals for these species are to assist in maintaining the species viability. This will require that we maintain the species across their existing ranges by avoiding actions that would adversely impact existing populations or degrade their occupied habitats to a quantity and/or quality below the threshold needed to maintain species persistence.

B. Specific Objectives

At this time, protection of existing occupied habitats should be the priority for management. Manipulation of these habitats should not be attempted until the needs of each species of concern occupying the site, and ecosystem dynamics of the site, have been evaluated. Manipulation of habitat on some sites might be desirable in some few cases, but this is not intended to say that management will always be necessary. Specific objectives include:

- protect existing occupied sites from activities that would alter microsite characteristics, including areas large enough to moderate fluctuations in humidity, temperature, and other environmental characteristics.

- identify and maintain potential refugia for the species such as down wood, exposed roots, litter, rocks, and debris piles.

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- maintain native plant communities around known site locations, including a diversity of tree, shrub and ground cover species to provide shade, food sources, and substrates for fungi.

- maintain uncompacted soil and undisturbed forest floor litter.

IV. HABITAT MANAGEMENT

A. Lessons from History

If we have learned anything from history, it should be that managment with a single or primary objective creates more problems than it resolves. Therefore, when managing habitat for a survey and manage species, other species, other resource objectives, and the ecosystem as a whole including natural succession, potential natural disturbances within the site, and influences from adjacent lands, all should be considered.

There are few records for most of these species and many of the older records provide little if any information on habitat or the microsite in which the specimens were found. Many of the historic sites from which these species have been recorded have been harvested, urbanized, or converted to agricultural or other uses and are no longer suitable habitat. However, new areas in which some of them occur have been discovered in the past two or three years.

Once extirpated from a site, populations of most gastropods are slow to recover. Fire is very destructive to snails and slugs, not only killing them outright, but in its destruction of logs and other woody debris that hold moisture and create microsites necessary for survival of these animals (Applegarth 1995; Burke, personal observations). Sites that appear to be suitable habitat for many gastropods, but which have been burned in the past, support few if any species or individuals even after 50 years and longer. Some of the more abundant, larger species begin repopulating these sites from adjacent stands after suitable habitat for them is restored, which may take many years. The first species to reappear in western Washington stands are usually the *Haplotrema* and *Vepericola* (Burke, personal observations). These species are the most abundant of the large snails in a variety of forest habitats. The time required for the abundance and diversity of the molluscan fauna to be restored to these sites is indicated by the much greater numbers of species and individuals found in old growth than in stands in which signs of fire (and other management in some cases) are still evident but not necessarily obvious. In these burned stands, we have an ecosystem that is lacking the components and functions provided by the mollusk fauna.

In contrast to severely burned areas, stands in which numerous large logs were left and which were not severely chared during the fire have been found to retain a portion of their mollusk fauna after an undetermined number of years

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but within a time that evidence of the burn was still apparent upon examination of the site. Logs were not measured, but are estimated to be well over 1000 linear feet per acre, and greater than 20 inches average diameter. Whether these gastropods remained through the burn, protected by the abundant logs, or they were able to more rapidly disperse back into the stand because of the cover provided by the logs has not been determined. What is apparent is that an abundance of large logs is important to many forest snails and slugs. Zero to two or rarely three species may be expected in burned stands without abundant logs remaining; five to seven species may be expected to be found in stands similarly treated but with the logs remaining; and in unburned stands 13 to 20 or more species may be found (Burke, unpublished report). Therefore, it is apparent that an intense burn leaves the biotic community under moist conifer stands with only a small fraction of its molluscan fauna for many years (possibly a century or more). Fire is generally not acceptable management for the habitat of these species.

B. Identification of Habitat Areas for Management

As of August 1998, it is considered important to protect all known occupied sites for these species on public lands due to their relative rarity. The Habitat Area will be identified as the area around known site locations including all habitat features that contribute to environmental conditions important to the species at the known site. In most cases, this could be achieved by areas up to tens of acres (ROD - C-5). For species that are known to be extremely rare, such as *H. pantherina*, larger areas may be considered in order to fully account for the unknown variables in habitat that may limit the suitability of the area for the species. As new data is compiled, consideration should be given to daily and annual movements within the life cycles of the organisms.

C. Management Within Habitat Areas

While the forest types in which these species occur are similar, the microhabitat that each species uses within the forest stands may vary. Examples of co-occurrence of survey and manage mollusk species are common. Therefore, as management is being considered for one species, specific habitat components for other species within the same stand may also need to be considered at the same time. Thus, real ecosystem management (saving all the pieces) is the concern.

In general, *Hemphillia* are quite vulnerable to heat and desiccation and use logs and other large woody debris, forest floor litter, and spaces under or between rocks as refugia - areas that maintain low temperature and moderate to high humidity. Management considerations should focus on maintaining the temperature and moisture regime of these microsites. This requires that overstory crown cover and understory vegetation be retained to shade the ground, provide humidity through evapotranspiration, condense fog and dew, intercept underground water and hold it on the site, and impede air movement that would tend to displace the cool moist air. Available crown cover information for these habitats is meager, but observations recorded in some western hemlock/Douglas-fir stands indicated summer crown cover of 70-90% plus.

Care should be taken to maintain or enhance the naturally occurring diversity of plant species in Habitat Areas. This will increase the range of hosts for a variety of species of fungi and make other food substrates available throughout the season. It will also provide assurance that specific plant species, if found to be critical in the life cycle of these mollusk species, are not inadvertently lost. As yet we know too little about the needs of these species to identify an optimum mix of tree species, but it appears that mixed stands of conifer and hardwoods provide the best habitat. Certainly, maintaining a mix such as occurs in natural late-successional stands, would provide a more diverse and complete set of conditions for multiple species and a more fully functioning ecosystem.

Management also requires maintenance and future recruitment of large and small woody debris, and a thick layer of litter and duff on the forest floor. These components provide cool moist places in which these animals spend the days, hide from predators, deposit their eggs, and find food. These animals use a wide variety of sizes of large woody debris. Logs appear to provide dispersal corridors as well as the above mentioned essential habitat elements. Habitat quality probably improves in direct proportion to the amount of large woody debris to a point where the debris interferes with the shade and humidity regulating function of the forest canopy cover. Specific types of cover, debris, litter, etc. will be determined by the species for which management is to be emphasized.

All Habitat Areas should be protected from fire events that cause direct mortality and loss of habitat. Prescribed fire treatments may be used to reduce fuel loading outside of Habitat Areas to protect those areas from catastrophic wildfire events.

Activities that cause soil compaction or disturbance to forest floor litter should be prohibited within designated Habitat Areas.

Protect occupied rockslides and talus areas from road construction, quarrying, and other major site disturbing activities that may cause temperature and/or humidity changes within the interspaces. These sites should be considered potential habitat when they lie within or near to suitable moist forest habtat areas, or at the edges of moist or wet mountain meadows.

Protect or manage occupied riparian sites as for other occupied sites, but consider increasing the width of occupied Riparian Reserves as part of management for these mollusk species.

Mollusk species are known to have limited dispersal abilities and the current species diversity is the result of generations of isolated populations developing unique characteristics. Care should be taken not to further isolate individual populations. Therefore, in addition to managing this species group within designated management areas, attempts should be made to connect these management areas to each other or to other reserves, such as Riparian Reserves and LSRs. This should be done either directly by locating them adjacent to occupied habitat within reserves, or indirectly by retaining suitable quantities of key habitat elements in harvest or project areas to provide a potential bridge or temporary "bank account" to accelerate future habitat development.

Historic sites need to be relocated and occupancy confirmed since the older known sites were located from museum records that may be 50 or 100 years old. Since site locations may not be accurately described, or habitats may have been modified over the years, adjacent sites that appear to be suitable habitat should also be searched for the species.

D. Other Management Issues and Considerations

At the time of the FEMAT Analysis most of these species were known from few sites, and few had even been seen by living malacologists. Much of the habitat from which they had previously been known had been developed into urban or agricultural areas, or entensively managed. It was not even known whether or not some of these species still survived.

Hemphillia pantherina is a species needing much more careful study. Because it is known from only one site, studies of it and its habitat need to be strictly regulated to prevent its inadvertent extirpation by researchers and other curious people.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

What is known of the habitat and ecology of this group of terrestrial gastropods, is from few, generally poorly documented observations. That they are found in generally undisturbed moist forests can be pieced together from the available descriptions of the locations in which they have been found. Literature sources

(Pilsbry 1948; Branson 1972, 1975, 1977, 1980; Branson and Branson 1984; Frest and Johannes 1993, 1995, 1996) give general site information at best, but detailed records of specific plants or other microhabitat elements are primarily from personal knowledge (Frest, personal communications; Burke, personal observations). Although, we can recognize some potential environments, we have too few observations to understand the full range of habitats or the ecological relationships of these animals.

Only a few of the land allocations of the known sites were available at this writing. Others need to be determined and recorded.

B. Research Questions

What is the specific geographic range of each of these species?

What is the range of habitat conditions tolerated by each species? What is the range of conditions required for populations to remain secure and viable?

Biological attributes:
- Plant associations;
- Specific plant species required/used;
- Specific foods;
- Amount of large woody debris desired;
- Optimum forest crown cover to maintain desired conditions;
- Other stand structure and components (e.g., small woody debris, litter, duff, water, etc.)?

Physical attributes:
- Elevation;
- Soil types, geology, trace elements;
- Temperature, humidity.

What are the stand characteristics (canopy cover, age, large woody debris, litter and duff, etc.) required to support the conditions required?

How do the required stand characteristics vary under different circumstances (elevation, slope, aspect, etc.)?

What stand size is required to provide sufficient area of suitable habitat?

How much time is required for recolonization of a site by species from adjacent populations?

What are the effects on mollusk species of herbicides and other chemicals used in forest management?

C. Monitoring Needs and Recommendations

Monitoring of known sites is recommended to track trends in populations (numbers, size, and density), reproduction, quantity and quality of habitats.

Monitoring is also recommended to determine impacts on habitats and populations from management activities, natural disturbances, and vegetative succession.

Monitoring Recommendations:

- Conduct surveys in spring and fall after the first heavy rainfall or frost.
- Record all environmental conditions where these species are found to better understand their habitats and management needs.
- Through surveys and studies, determine the extent of the species' range, and the habitats and ecology of the species.
- Monitor sites for conditions and trends of populations.

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FSEIS (a)
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FEMAT (b)
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SECTION NO. 7
Monadenia (Shastelix) chaceana
Chace Sideband

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Draft Management Recommendations
for
Monadenia (Shastelix) chaceana, the Chace Sideband (land snail)

Version 2.0

by

Ted R. Weasma

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EXECUTIVE SUMMARY

Species: *Monadenia (Shastelix) chaceana* Berry (Chace Sideband)

Taxonomic Group: Mollusk (Phylum Mollusca) Snail (Class Gastropoda), Land Snail (Order Pulmonata)

ROD Components: Survey and Manage Strategies 1 & 2

Other Management Status: None identified at this time

Range: The range is defined by 33 known sites (J-2, p. 316). Most of these known sites are within the Shasta and Little Shasta River Drainages, Siskiyou County, California. Recent discoveries in Douglas County, Oregon have extended the northern range to as far north as Douglas County in Oregon and as far west as the Weaverville Ranger District of Shasta-Trinity National Forest.

Specific Habitat: Habitat information is based on the limited number of known sites as outlined above. The species occupies late-successional forest and open talus or rocky areas, especially the lower one third of a talus slope that generally contains the largest and most stable habitat elements. Mollusks, which inhabit talus slopes, also utilize the surrounding forest areas during moist, cool conditions.

Threats: Given that little information is available about the habitat needs of the species, the following general statements can be applied. Habitat alteration by either human or natural means is considered to be the major threat to the species. Land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, snails are very vulnerable to fire and management activities that increase temperature, decrease moisture, or decrease food supplies available in populated sites. All activities that directly or indirectly alter a site's ecological parameters, such as moisture conditions (too dry during spring and/or fall, or too wet), shade, temperature, soil compaction (compacted), food supplies, or dispersal routes can adversely affect a population. No specific threats were identified in Appendix J-2.

Management Recommendations: Manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Adjacent forested areas should be managed to provide shade, coarse woody debris, and uncompacted forest litter. Due to the rarity of known populations, sites should be protected from wildfire events.

Information Needs: Information is needed on the actual range of the species, the location of other populations, the stability of the known populations, and the factors that control population stability.

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I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

The genus *Monadenia* was first considered to belong to the genus *Aglaia* in part (Von Martens, 1860. Die Heliceen, p. 122; Binney, 1869, L. & W. Sh. N. A. 1:161; 1878. Terr. Moll., 5, in Bull. Mus. Comp. Zool., 4: 350.). It became *Aglaja* according to Binney's work in 1890 (Bull. Mus. Comp. Zool., 19: 213. Not *Aglaja* Albers, 1850, nor of Reiner. 1804).

The genus *Monadenia* was established by Pilsbry in 1895 (Man. Conch., 9: 198) with *Helix fidelis* Gray established as the type for this new genus.

The species *Monadenia chaceana* was first described by Berry in 1940 (J. Entomology & Zoology 32: 1-17). Berry Roth in 1981 (Proc. Cal. Acad. Sci. 42: 379-407) established the subgenus *Monadenia (Shastelix) chaceana* and dropped it in 1986 (Veliger 29(2): 169-182).

B. Species Description

1. Morphology

Burch & Pearce (1990) consider the following to be key characteristics for *Monadenia*. "Embryonic whorl sculpture irregularly granulose, not papillose; embryonic whorls usually carinate and adult shell may be carinate; spiral color band not far above the shell periphery; shell large; reproductive system with one club shaped mucous gland (Fig. 9.189*b*); . . .". Similar species such as *Helminthoglypta* are not carinate, have radial lines or papillae on the embryonic whorl, and have the spiral color band well above the shell periphery.

Berry describes the species as follows: "Shell of but moderate size, weight, and thickness; spire low-conic to moderately elevated; whorls 5 ½ to 6, subangulate and carinate above the middle during juvenility, subcarinate at adolescence, but becoming obtusely angular and finely quite well rounded at maturity; base tumid, the umbilicus open, steep-walled, permeable to apex, and contained on the average about 8.4 times (7.45 to 9.88 of those measured) in the major shell diameter. Aperture somewhat descending above, oblique, rounded to round-ovate, slightly or not at all extended below; peristome nearly simple above, elsewhere usually little thickened and but moderately everted, terminating below in a very moderate columellar flare which covers only the edge of the umbilicus.

"Embryonic shell swollen, of 1-3/4 to 2 whorls; the surface initially smooth, but almost at once breaking into a few irregular axial waves

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succeeded by a close, fine, crowed granulation, which abruptly ceases with the first post-embryonic whorl, the often heavy but extremely variable growth-striae thenceforth becoming the dominate feature; a few indistinct, elongate, and commonly confluent papillae arranged in rather distant forward-descending series appear on the early turns, but gradually give way on the latter whorls to a weak and not very regular spiral striation, which may become quite indistinct on the base; general surface between the striae and growth-lines very finely *microscopically* wrinkled in a cloth-like pattern.

"Periostracum smooth and lustrous; deep brown, encircled by a conspicuous dark-brown band about 2 mm. wide just above the periphery, bordered below by a much narrower yellowish band and a yet narrower band of the same pale tone just above, while on the shoulder some shells show varying traces of yet another band of intermediate brownish tone, best to be seen in juveniles."

The maximum diameter of measured specimens is 25.5 mm. with a maximum altitude of 15.+ mm., and an umbilicus diameter up to 3.4 mm. The number of whorls vary between 5 and 6.

Berry goes on to remark that "Superficially the shell of this species is exceedingly similar to *M. mormonum cala* (Pilsbry, 1900: 128), but differs in the smoother and glossier surface, weaker and more distant spiral striations, weaker papillation of the post-embryonic whorls, entire lack of the process-bearing granules within the umbilicus of the immature shell so characteristic of the perfect specimens of *cala*, and significantly in the much closer and finer embryonic papillation. *Chaceana* differs from *churchi* Hanna & Smith (paratypes !) in its larger size, the presence of weak though distinct spiral striation, the much closer and finer granulation of the embryonic shell, the weaker and differently fashioned papillation of the early post-embryonic whorls, and the absence of distinct granulation inside the umbilicus."

Soft body anatomy has not been fully described for this species. Roth (1986) states that anatomical mounts show that this species is clearly a *Monadenia* s. s. and not related to *Shastelix*. Refer to Roth (1986) for a short description of the reproductive organs.

2. Reproductive Biology

Data have not been published on the reproductive biology of this species. All *Monadenia* have a reproductive system with a dart and a single tubular mucus gland apparatus associated with or in close proximity to the vagina (Miller and Naranjo-Garcia, 1991). Species of this genus are hermaphroditic. The species lays eggs in loose soil (several 10s), is likely to live 6+ years, and probably matures in 2 years (pers. comm. B. Roth, 1996).

3. Ecology

During the summer, the species will be found under rocks or large woody debris, which serve as refuge sites from desiccation. It is not expected to be found under a moss layer on trees as with *Monadenia fidelis*. During the wet seasons, it may be found away from refugia, foraging for green vegetation and fruit, feces, old leaves, leaf mold, and fungi. Mollusks, which inhabit talus slopes, also utilize the surrounding forest areas during moist, cool conditions, ranging out from the refugia to forage in litter of the the adjacent forest floor. Vegetation within the surrounding forest not only moderates the temperature and moisture conditions within the rock habitats, but provides food, loose soil, and litter conditions necessary for egg laying.

Generally, the lower one third of a talus slope contains the largest, most stable habitat elements. Because of the long-term stability in these areas and larger interstitial spaces between the rocks, microsite conditions are more favorable and provide dependable refugia sites. It is important, therefore, to avoid disturbance of the bottom of the slope that could result in loss of these refugia areas and destabilizion of the entire talus field.

The species probably has an efficiency rate in the high forties for assimilation of food materials, a low rate that results in the dispersal of intact fungal spores. Birds, beetles, shrews, mice, raccoons, carnivorous mollusks, and snakes are likely predators. The species is crepuscular (active only during dawn and dusk during the spring and fall seasons). Species of *Vespericola, Helminthoglypta, Trilobopsis, and Haplotrema* commonly occur in the same geographic area as *Monadenias*.

C. Range, Known Sites

The known range for this species is based on limited data and is likely an artifact of collecting. Most of the known sites are within the Shasta and Little Shasta River Drainages. The **Type Locality** is "Among rocks about halfway up a spur of Badger Mountain on the west side of Shasta River canyon, not far from its mouth, in Siskiyou Co., CA." according to Frest, 1993. The species is known from the general vicinity of the **Type Locality** in the Hornbrook Quadrangle and from one site in the Yreka Quadrangle. The species has been found in talus habitat (a rockslide) 1/4 mile below the Copco Dam in the Shasta River Canyon and a rocky area near the mouth of the Shasta River Canyon. It

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has been recently located as far north as Douglas County, Oregon, near the town of Tiller. Most known sites are on non-federal lands.

The range is expected to extend as far north as Douglas County in Oregon and as far west as the Weaverville Ranger District of Shasta-Trinity National Forest. Specimens conformable to *Monadenia chaceana* have also been found east of Ashland, Oregon. Refer to the Mollusk Survey and Manage Database for specific locations.

D. Habitat Characteristics and Species Abundance

The species is rare and known from 33 sites. It has been found in the lower reaches of major drainages, in talus and rock slides, under rocks and woody debris in moist conifer forests, in caves, and in shrubby areas in riparian corridors. Rocks and large woody debris serve as refugia during the summer and late winter seasons. Temperature is lower and humidity is higher under talus than in the surrounding environment. While the specific food requirements of this species is not known, a variety of vegetation, subsurface roots, fungi, and organic debris is typically found in talus slopes. Small invertebrates that may serve as food sources also inhabit the talus environment. Forest litter and coarse woody debris in the semi-dry areas in which these species occur is considered necessary to provide food (shelter and substrate for fungi) and temporary cover when foraging.

Population density at known sites has not been determined.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage

According to the FEMAT report, the mollusk assessment suggests that the options considered in the outcome assessment were less effective in providing for mollusks than for any other species group. High degrees of endemism, rareness, and habitat specialization account, in part, for the low ratings. Under the selected management option (Option 9), there would be a 23% probability that the species would be well-distributed across Federal lands, a 37% probability that the species would remain viable but with gaps in distribution, a 27% probability that populations would be restricted to refugia, and a 13% probability that it would be extirpated (FEMAT Table IV-22).

Only a small portion of the species' range is thought to occur on federal land. Though Riparian Reserves may provide some measure of protection, some locations could occur outside reserves.

B. Major Habitat and Viability Considerations

Maintaining refuge sites with appropriate microclimate conditions during the summer and winter within and around occupied habitat is considered critical. Retaining large woody debris, leaf litter, uncompacted soil, and canopy cover may assist in maintaining summer shade and refuge sites with respect to these habitat conditions.

The survival of mollusk species in semi-xeric (dry) conditions is especially dependent upon the presence of adequate refuge sites during the hot summer and cold winter months. An increase in temperature or decrease in moisture during the hot summer months is much more likely to adversely affect these subspecies than those that live in a mesic (moist) environment. The range of environmental conditions that these species can tolerate is not known, but desiccation is the most common cause of mortality for mollusks in general. These species are tolerant of drier conditions than are the subspecies of *Monadenia fidelis*.

The number of population sites required to maintain species viability is unknown; however, it can be assumed that the likelihood of species viability increases with the number of populations.

C. Threats to the Species

Given that little information is available about the habitat needs of the species, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities that increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means (including fire, herbicide use, recreation development), over-collecting, and disturbance during aestivation may constitute major threats to this species.

D. Distribution Relative to Land Allocations

Six (6) of the known locations are on private land but near public land. New sites have recently been discovered on BLM lands and National Forest lands in the vicinity of Yreka, California and Tiller, Oregon.

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The management goal for this species is to maintain the species across the known range by avoiding actions that would degrade occupied habitat or adversely impact the viability of existing populations.

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B. Specific Objectives

- C Maintain uncompacted soil in and near populated sites.

- C Maintain undisturbed talus and rocky outcrops (most important in the lower third of the slope).

- C Maintain vegetative community and shading in the population area.

- C Maintain current volume of coarse woody debris as food sources (substrate for fungi) and refuge sites, and protect future sources of coarse woody debris.

- C Maintain soil temperature and moisture regime of the refugia sites (cool and moist during the summer).

IV. HABITAT MANAGEMENT

A. Lessons from History

Knowledge of the species' range and habitat requirements is likely to change, as there has been little to no field research outside of the area around Yreka, California. Over-collecting has led to the extirpation of many species in Hawaii (Hadfield 1986), and caution should be exercised when surveying for this species in order to ensure that the activities do not inadvertently extirpate populations. Fire management activities that increased the intensity, duration, or frequency of fire; forest management activities that affected shade; and road construction that directly disturbed sites have significantly impacted other *Monadenia* species in the Pacific Northwest.

B. Identification of Habitat Areas for Management

As of August 1998, it is considered important to protect all known occupied sites on public lands due to the relative rarity of these subspecies. The Habitat Area will be identified as the area around known site locations including all habitat features that contribute to environmental conditions important to the species at the known site. In most cases, this could be achieved by areas up to tens of acres (ROD C-5). As new data is compiled, consideration should be given to daily and annual movements within the life cycles of the organisms.

C. Management Within Habitat Areas

In general, manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf

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and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Adjacent forested areas should be managed to provide shade, coarse woody debris, and uncompacted forest litter. Due to the rarity of known populations, sites should be protected from wildfire events. Mitigation measures outlined in Appendix J-2 stress the importance of the proper implementation of Riparian Reserves under option 9.

D. Other Management Issues and Considerations

Prescribed fire may be considered as a tool to be used outside of Habitat Areas to reduce the risk of catastrophic natural fire. Prescribed burning should be designed to avoid significant impacts to the habitat conditions in the management area as outlined in Section II-B.

Consideration should be given to locating and managing additional sites and determining the actual biogeography of the species.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

Present knowledge of this species is based on limited collecting from 2 known population areas. Significant data gaps exist in our knowledge of the species' fossil record and its biologic and environmental needs. The species' present and former distribution, and the factors that have controlled distribution, diet, reproductive rates, and dispersal rates need further investigation. Local and range-wide population trends are not known.

Field research associated with any mollusk species often results in detections in different habitats than expected based on prior knowledge. Range extensions are also common. Surveys outside of known habitat conditions may be helpful in determining the full range of habitat conditions in which the organisms can survive.

B. Research Questions

- What are the food requirements of this species, and are any of these food requirements unique to the species?

- What is the range of environmental conditions that this species can tolerate, and how long can extremes be tolerated?
- Are there other populated sites?
- What factors control the species' rate and distance of dispersal?
- What is the species' natural life span?
- What adaptations has the species made that allows it to be more xeric tolerant than other *Monadenia* species?
- What is the actual physical range of the species?
- How far does an individual range away from its refuge site?
- What is the population density of the known sites?

C. Monitoring Needs and Recommendations

Known sites on public land should be monitored to assess population trends and to attempt to determine the factors that control those trends. Monitoring strategies should be designed to assist in determining if the implementation of the plan is resulting in the protection of habitat for these subspecies. In addition, monitoring should be designed to ensure that site disturbance or collection activities do not extirpate local populations.

VI. REFERENCES

Appendix J2. 1994. Final Supplemental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl., Appendix J2, Results of Additional Species Analysis. USDA Forest Service and USDI Bureau of Land Management, i-viii, 476p.

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SECTION NO. 8
Monadenia (Shastelix) churchi
Klamath or Church's Sideband

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Draft Management Recommendations
for
Monadenia (Shastelix) churchi, the Klamath or Church's Sideband

Version 2.0

by

Ted R. Weasma

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EXECUTIVE SUMMARY

Species: *Monadenia churchi* (Klamath or Church's Sideband)

Taxonomic Group: Mollusk (Mollusca) Snail (Gastropoda) Land Snail (Order pulmonata)

ROD Components: Survey and Manage Strategy 1 & 2

Other Management Status: None identified at this time

Range: The species is known from 59 known sites at 19 locations in Tehama, Trinity, Shasta, Siskiyou, and Butte Counties, California. Sites occur within the Hayfork AMA.

Specific Habitat: Habitat associations vary to some degree between the eastern and western populations of this species. In the western portion of the range, it is found at upland sites associated with but not obligated to limestone substrates and with various rock types in riparian corridors. Eastern populations are largely associated with riparian areas. It may also be found under forest debris under heavy shade on wooded hillsides, around brushy areas, and in late-seral pine-oak woodlands.

Threats: Given that little information is available about the habitat needs of the species, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities that increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means (including fire, herbicide use, recreation development), over-collecting, and disturbance during aestivation may constitute major threats to this species.

Road building and substantial road maintenance were identified as specific issues of concern for populations in the western portions of the range in Appendix J-2. For eastern populations proper implemetation of Riparian Reserves were identified as an issue of concern.

Management Recommendations: In general, manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Adjacent forested areas should be managed to provide shade, coarse woody debris, and uncompacted forest litter. Due to the rarity of known populations, sites should be protected from wildfire events.

Information Needs: Information is needed on the actual range of the species, the location of other populations, the stability of the known populations, and the factors that control population stability.

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

The genus *Monadenia* was first considered to belong to the genus *Aglaia* in part (Von Martens, 1860. Die Heliceen, p. 122; Binney, 1869, L. & W. Sh. N. A. 1:161; 1878. Terr. Moll., 5, in Bull. Mus. Comp. Zool., 4: 350.). It became *Aglaja* according to Binney's work in 1890 (Bull. Mus. Comp. Zool., 19: 213. Not *Aglaja* Albers, 1850, nor of Reiner. 1804).

The genus *Monadenia* was established by Pilsbry in 1895 (Man. Conch., 9: 198) with *Helix fidelis* Gray established as the type for this new genus.

The species *Monadenia churchi* was established by Hanna & Smith in 1933 (Nautilus, 46: 79, pl. 5, figs. 1-5; pl. 6, fig. 8).

Berry Roth in 1981 placed it in a new subgenus *Monadenia (Shastelix) churchi* (Proc. Cal. Acad. Sci. 42: 379-407). He dropped the subgenus in 1986 (Veliger 29(2): 169-182).

B. Species Description

1. Morphology

Burch & Pearce (1990) considered the following to be key characteristics for *Monadenia*. "Embryonic whorl sculpture irregularly granulose, not papillose; embryonic whorls usually carinate and adult shell may be carinate; spiral color band not far above the shell periphery; shell large; reproductive system with one club shaped mucous gland (Fig. 9. 189*b*); . . .". Similar species such as *Helminthoglypta* are not carinate, have radial lines or papillae on the embryonic whorl, and have the spiral color band well above the shell periphery.

Hanna & Smith describe the species as follows: "Shell medium sized, non-carinate, umbilicate; with a somewhat low spire; whorls 5-1/4, evenly rounded; outer lip slightly reflected; color pale brown, with a peripheral band of darker brown than the rest of the shell bounded above and below by light cream-colored bands, the upper about equal in width to the dark band, the lower a little wider; nuclear whorls 1-1/3, sculptured with densely set, wavy, somewhat elongated tubercles arranged roughly in spiral order; remaining whorls with sparse elongated tubercles, grouped principally in a protractive spiral order, more pronounced on the upper surface, becoming obsolete on the lower surface and in the umbilicus. Extremely fine, wavy, axial sculpture is pronounced on the postnuclear whorls and is superimposed on the somewhat irregular, low axial growth ridges, but does not extend to the top of the tubercles. This sculpture gives the shell a moderately smooth, dull appearance when viewed without a lens. Alt. 11.3 mm., diam. 20 mm." Pilsbry found the range to be 9.7 mm. to 14.0 mm. in altitude and 17.8 mm. to 23.5 mm. in diameter.

Hanna & Smith go on to say that "In many living adult specimens the epidermis, apparently very thin, is badly eroded on the spire." They also state that "The tubercles are usually elongate in a protractive spiral direction but do not have any regular arrangement otherwise. The tops of the tubercles are polished and do not bear hairs in most of the individuals examined, but in some of the specimens from Trinity County there is evidence of short blunt extensions of the epidermis in the umbilical region; these do not leave a pit or other mark on the tubercles when they are removed or absent. The shape of the tubercles is usually elongate spirally but this is subject to considerable variation even on the same specimen, some of them being rounded or pear-shaped."

They also say that "Specimens from Trinity County are darker in color than those in the type lot and the tubercles are crowned sometimes with minute fin-shaped projections of the epidermis."

The design and shape of the papillae as well as the habitat are similar to that of *M. setosa* but the size, thickness of shell, and bristles separate it from that species (Talmadge 1952).

According to Hanna and Smith "The mantle of *M. churchi* has a series of jet black irregularly-shaped spots, sparsely arranged over the surface. The jaw has seven heavy ribs. There are 24 rows of teeth on each side of the central, and the first laterals have a small cusp on the inner side." Refer to Hanna & Smith for further discussion of the soft body anatomy.

2. Reproductive Biology

Data have not been published on the reproductive biology of this species. All *Monadenia* have a reproductive system with a dart and a single tubular mucus gland apparatus associated with or in close proximity to the vagina (Miller and Naranjo-Garcia, 1991). Species of this genus are hermaphroditic and may copulate continuously for more than 23 hours. The species lay eggs (several 10s), are likely to live 6+ years, and probably mature in 2 years (pers. comm. B. Roth, 1996). Loose soil is considered necessary for egg-laying.

3. Ecology

During the summer, the species will be found under rocks or large woody debris that serve as refuge sites from desiccation. It is not expected to be found under the moss layer on trees as is *Monadenia fidelis*. During the wet seasons, it may be found away from refugia, foraging for green vegetation and fruit, feces, old leaves, leaf mold, and fungi. Mollusks that inhabit talus slopes also utilize the surrounding forest areas during moist, cool conditions, ranging out from the refugia to forage in litter of the the adjacent forest floor. Vegetation within the surrounding forest not only moderates the temperature and moisture conditions within the rock habitats, but provides food, loose soil and litter conditions necessary for egg laying.

Generally, the lower one third of a talus slope contains the largest, most stable habitat elements. Because of the long-term stability in these areas and larger interstitial spaces between the rocks, microsite conditions are more favorable and provide dependable refugia sites. It is important, therefore, to avoid disturbance of the bottom of the slope that could result in loss of these refugia areas and destabilizion of the entire talus field.

The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate that allows viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, snails and slugs represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active. Birds, beetles, shrews, mice, raccoons, carnivorous mollusks, and snakes are likely predators. The species is crepuscular (active only during dawn and dusk during the spring and fall seasons). Species of *Vespericola, Helminthoglypta, Trilobopsis, and Haplotrema* commonly occur in the same geographic area as *Monadenias*.

C. Range, Known Sites

The known range for this species is based on limited data and is likely an artifact of collecting. *Monadenia churchi* is a fairly widespread California endemic with 59 known sites distributed in 19 local populations in Shasta, Siskiyou, Trinity, Tehama, and Butte counties. New sites have recently been located in the Yolla Bolly-Middle Eel Wilderness Area.

The **Type Locality** is a lava rockslide 2.1 miles east of Payne's Creek Station, Tehama County, California. For specific sites refer to the Mollusk Survey and Manage Database.

D. Habitat Characteristics and Species Abundance

Habitat associations vary to some degree between the eastern and western populations of this species (Appendix J-2, p. 317). In the western portion of the range, it is found at upland sites associated with but not obligated to limestone substrates (Frest & Johannes 1993) and with various rock types in riparian corridors. Eastern populations are largely associated with riparian areas, but may also be found under forest debris in heavy shade on wooded hillsides (Pilsbry 1939; Roth and Pressley 1986; Roth 1993; Frest and Johannes 1993) and around brushy areas and pine-oak woodlands.

Rocks and large woody debris serve as refugia during the summer and late winter seasons. Temperature is lower and humidity is higher under talus than in the surrounding environment. While the specific food requirements of this species is not known, a variety of vegetation, subsurface roots, fungi, and organic debris is typically found in talus slopes. Small invertebrates that may serve as food sources also inhabit the talus environment. Forest litter and coarse woody debris in the semi-dry areas in which these species occur is considered necessary to provide food (shelter and substrate for fungi) and temporary cover when foraging.

Population density at known sites has not been determined.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage

According to the FEMAT report, the mollusk assessment suggests that the options considered in the outcome assessment were less effective in providing for mollusks than for any other species group. High degrees of endemism, rareness, and habitat specialization account, in part, for the low ratings. Under the selected management option (Option 9), there would be a 40% probability that the species would be well-distributed across Federal lands, a 33% probability that the species would remain viable but with gaps in distribution, a 13% probability that populations would be restricted to refugia, and a 13% probability that it would be extirpated (FEMAT Table IV-22).

Ratings reflect the relative rarity of the species and the potential for disturbance at sites on AMA and matrix lands.

B. Major Habitat and Viability Considerations

Maintaining refuge sites with appropriate microclimate conditions during the summer and winter within and around occupied habitat is considered critical. Retaining existing talus slopes, large woody debris, leaf litter, uncompacted soil, and canopy cover may assist in maintaining summer shade and refuge sites with respect to these habitat conditions.

The survival of mollusk species in semi-xeric (dry) conditions is especially dependent upon the presence of adequate refuge sites during the hot summer and cold winter months. An increase in temperature or decrease in moisture during the hot summer months is much more likely to adversely affect these subspecies than those that live in a mesic (moist) environment. The range of environmental conditions that these species can tolerate is not known, but desiccation is the most common cause of mortality for mollusks in general. These species are tolerant of drier conditions than are the subspecies of *Monadenia fidelis*.

The number of population sites required to maintain species viability is unknown; however, it can be assumed that the likelihood of species viability increases with the number of populations.

C. Threats to the Species

Given that little information is available about the habitat needs of the species, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities which increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means (including fire, herbicide use, recreation development), over-collecting, and disturbance during aestivation may constitute major threats to this species.

Road building and substantial road maintenance were identified as specific issues of concern for populations in the western portions of the range in Appendix J-2. For eastern populations proper implemetation of Riparian Reserves were identified as an issue of concern.

D. Distribution Relative to Land Allocations

There are 4 locations within the Hayfork AMA, 6 in LSR and the Yolla Bolly-Middle Eel Wilderness Area, 1 in a combination of AMA and private, 7 in matrix, and 2 in a combination of matrix and private land (Appendix J-2 p. 317).

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The management goal for this species is to maintain the species across its existing range by avoiding actions that would degrade occupied habitat or adversely impact the viability of existing populations.

B. Specific Objectives

- Maintain uncompacted soil in and near populated sites.

- C Maintain undisturbed talus and rocky outcrops (most important in the lower third of the slope).

- C Maintain vegetative community and shading in the population area.

- C Maintain current volume of coarse woody debris as food sources (substrate for fungi) and refuge sites, and protect future sources of coarse woody debris.

- C Maintain soil temperature and moisture regime of the refugia sites (cool and moist during the summer).

IV. HABITAT MANAGEMENT

A. Lessons from History

Knowledge of the species' range and habitat requirements is likely to change as additional areas are surveyed. Over-collecting has led to the extirpation of many species in Hawaii (Hadfield 1986), and caution should be exercised when surveying for this species in order to ensure that the activities do not inadvertently extirpate populations. Fire management activities that increased the intensity, duration, or frequency of fire; forest management activities that affected shade; and road construction that directly disturb sites have significantly impacted other *Monadenia* species in the Pacific Northwest.

B. Identification of Habitat Areas for Management

As of August 1998, it is considered important to protect all known occupied sites on public lands due to the relative rarity of this species. The Habitat Area will be identified as the area around known site locations that includes all habitat features contributing to environmental conditions important to the species at the known site. In most cases, this could be achieved by areas up to tens of acres (ROD C-5). As new data is compiled, consideration should be given to daily and annual movements within the life cycles of the organisms.

C. Management Within Habitat Areas

In general, manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Adjacent forested areas should be managed to mitigate the drying effects of the wind and to provide shade, coarse woody debris, and uncompacted forest litter. Due to the rarity of known populations, sites should be protected from wildfire events.

D. Other Management Issues and Considerations

Prescribed fire may be considered as a tool to be used outside of Habitat Areas to reduce the risk of catastrophic natural fire. Prescribed burning should be designed to avoid significant impacts to the habitat conditions in the management area as outlined in Section II-B.

Consideration should be given to locating and managing additional sites and determining the actual biogeography of the species.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

Present knowledge of this species is based on limited collecting from known population areas. The species' present and former distribution, and the factors that have controlled distribution, diet, reproductive rates, and dispersal rates need further investigation. Local and range-wide population trends are not known.

Field research associated with any mollusk species often results in detections in different habitats than expected based on prior knowledge. Range extensions are also common. Surveys outside of known habitat conditions may be helpful in determining the full range of habitat conditions in which the organisms can survive.

B. Research Questions

- What are the food requirements of this species, and are any of these food requirements unique to the species?
- What is the range of environmental conditions that this species can tolerate, and how long can extremes be tolerated?
- Are there other populated sites?
- What factors control the species' rate and distance of dispersal?

- What is the species' natural life span?
- What adaptations has the species made that allows it to be more xeric tolerant than other *Monadenia* species?
- What is the actual physical range of the species?
- How far does an individual range away from its refuge site?
- What is the population density of the known sites?

C. Monitoring Needs and Recommendations

Known sites on public land should be monitored to assess population trends and to attempt to determine the factors which control those trends. Monitoring strategies should be designed to assist in determining if the implementation of the plan is resulting in the protection of habitat for these subspecies. In addition, monitoring should be designed to ensure that site disturbance or collection activities do not extirpate local populations.

VI. REFERENCES

Appendix J2. 1994. Final Supplemental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl., Appendix J2, Results of Additional Species Analysis. USDA Forest Service and USDI Bureau of Land Management, i-viii, 476 p.

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SECTION NO. 9
Monadenia fidelis minor
Dalles Sideband

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Draft Management Recommendations
for
Monadenia fidelis minor, the Dalles Sideband (land snail)

Version 2.0

by

Ted R. Weasma

January 1999

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EXECUTIVE SUMMARY

Species: *Monadenia fidelis minor* (Dalles sideband)

Taxonomic Group: Mollusk (Mollusca) land snail (Gastropoda) (Order Pulmonata)

ROD Components: Survey and Manage Strategies 1 & 2

Other Management Status: Oregon Natural Heritage Program List 1 species (critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation, typically with 5 or fewer occurrences). Also a Federal Species of Concern.

Range: This species is known from 15 sites within the Columbia Gorge in the vicinity of the Dalles on both sides of the river and at the confluence of the Deschutes River. The species may have occurred historically in the central and part of the eastern Columbia Gorge and south up the Deschutes River Valley as far as 50 miles from the confluence.

Specific Habitat: The species has been found in talus habitat, moist rocky areas (especially around seeps and springs), and shrubby areas in riparian corridors.

Threats: Given that little information is available about the habitat needs of the species, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities that increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means, including fire, herbicide use, recreation development, over-collecting, and disturbance during aestivation may constitute a major threat to this species. Road building and road maintenance have been identified as specific threats.

Management Recommendations: Manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Adjacent forested areas should be managed to provide shade, coarse woody debris, and uncompacted forest litter. Due to the rarity of known populations, sites should be protected from wildfire events.

Information Needs: Information is needed on the actual range of this species, the location of other populations outside of the known sites, the viability and stability of the known populations, and the factors that control the populations stability.

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I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

The genus *Monadenia* was first considered to belong to the genus *Aglaia* in part (Von Martens, 1860. Die Heliceen, p. 122; Binney, 1869, L. & W. Sh. N. A. 1:161; 1878. Terr. Moll., 5, in Bull. Mus. Comp. Zool., 4: 350.). It became *Aglaja* according to Binney's work in 1890 (Bull. Mus. Comp. Zool., 19: 213. Not *Aglaja* Albers, 1850, nor of Reiner. 1804).

The genus *Monadenia* was established by Pilsbry in 1895 (Man. Conch., 9: 198) with *Helix fidelis* Gray established as the type for this new genus.

Monadenia fidelis minor (Binney) was described by Henderson in 1936 (Univ. Colo. Studies, 23: 253). He restricted the subspecies to the Dalles form.

B. Species Description

1. Morphology

Burch & Pearce (1990) consider the following to be key characteristics for *Monadenia*. "Embryonic whorl sculpture irregularly granulose, not papillose; embryonic whorls usually carinate and adult shell may be carinate; spiral color band not far above the shell periphery; shell large; reproductive system with one club shaped mucous gland (Fig. 9.189*b*); . . .". Similar species such as *Helminthoglypta* are not carinate, have radial lines or papillae on the embryonic whorl, and have the spiral color band well above the shell periphery.

Pilsbry (1939) gives the following description: "The shell is smaller and thinner than *fidelis*, colonial buff to cartridge buff, the base dilute russet or dilute chestnut, with a few or many pale radial streaks, the supraperipheral band somewhat darker; between band and suture the color varies from cartridge buff to ochraceous-tawny, in either case with oblique streaks or maculae of brown, and usually one or two faintly traced spiral bands. Under the microscope the upper surface shows patches of minute lineolation over a somewhat irregular surface produced by displaced spirals. The lip is thin, narrowly reflected below." "Diameter of Binney's type figure 25.2 mm.; topotypes measure from height 12 mm., diameter, 20 mm., 5 1/2 whorls, to height 15.2, diameter 24 mm., 6 whorls."

He goes on to say "By microscopic sculpture this small race, at the eastern limit of the genus, resembles the large forms from farther west at Carson and near Mt. Hood, more than the typical *fidelis* from still farther west. In the latter microscopic lineolation is almost or quite obsolete."

Soft body anatomy is not required for field identification work and is, therefore, not discussed here.

2. Reproductive Biology

Data have not been published on the reproductive biology of this species. All *Monadenia* have a reproductive system with a dart and a single tubular mucus gland apparatus associated with or in close proximity to the vagina (Miller and Naranjo-Garcia 1991). Species of this genus are hermaphroditic and may copulate continuously for more than 23 hours. The species lay eggs (several 10s), are likely to live 6+ years, and probably mature in 2 years (pers. comm. B. Roth, 1996).

Loose soil is considered to be necessary for egg laying.

3. Ecology

The species is crepuscular (active only during dawn and dusk during the spring and fall seasons). During the summer, it may be found under rocks in suitable substrate that serve as refuge sites from desiccation. It is not expected to be found on trees below a moss layer as with *Monadenia fidelis fidelis*. During the wet seasons, it may be found away from refugia, foraging for green vegetation and fruit, feces, old leaves, leaf mold, fungi, or woody debris. Mollusks that inhabit talus slopes also utilize the surrounding forest areas during moist, cool conditions, ranging out from the refugia provided by the rocks to forage in the adjacent forest floor litter. Vegetation within the surrounding forest not only moderates the temperature and moisture conditions within the rock habitats, but provides food, loose soil, and litter conditions necessary for egg laying.

Generally, the lower one-third of a talus slope contains the largest, most stable habitat elements. Because of the long-term stability in these areas and larger interstitial spaces between the rocks, microsite conditions are more favorable and provide dependable refugia sites. It is important, therefore, to avoid disturbance of the bottom of the slope that could result in loss of these refugia areas and destabilization of the entire talus field.

M. fidelis minor does not occur in springs adjacent to the talus in which it is often found. According to Frest "There is some indication that this species hibernates; that is, is difficult to find during the winter and during dry weather, even if other commonly-associated taxa such as *Vespericola* and *Oreohelix* are active."

The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate that results in the viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, snails and slugs represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active. Birds, beetles, shrews, mice, raccoons, carnivorous mollusks, and snakes are likely predators. Species of *Vespericola, Allagona, and Haplotrema* commonly occur in the same geographic area as *Monadenias*. It has been found with the Larch Mountain Salamander *Plethodon larselli*.

C. Range, Known Sites

A total of 15 known sites occur within the Columbia Gorge in the vicinity of the Dalles on both sides of the river and at the mouth of the Deschutes River. The species is considered to have occurred historically in the central and part of the eastern Columbia Gorge and south up the Deschutes River Valley as far as 50 miles from the mouth.

A significant part of the range is outside of the range of the Northern Spotted Owl.

D. Habitat Characteristics and Species Abundance

The species is rare and known only from a few sites. It is associated with talus habitat and moist rocky areas, especially around seeps and springs, though it is not found in the springs or seeps, nor is it considered to be a talus obligate. Rocks and large woody debris serve as refugia during the summer and late winter seasons. Temperature is lower and humidity is higher under talus than in the surrounding environment. While the specific food requirements of this species is not known, a variety of vegetation, subsurface roots, fungi, and organic debris is typically found in talus slopes. Small invertebrates that may serve as food sources also inhabit the talus environment. Forest litter and coarse woody debris are considered necessary to provide food (shelter and substrate for fungi) and temporary cover when foraging.

Population density at known sites has not been determined.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage

According to the FEMAT report, the mollusk assessment suggests that the options considered in the outcome assessment were less effective in providing for mollusks than for any other species' group. High degrees of endemism, rareness, and habitat specialization account, in part, for the low ratings. Under the selected management option (Option 9), there would be a 43% probability that the species would be well-distributed across Federal lands, a 35% probability that the species would remain viable but with gaps in distribution, a 22% probability that populations would be restricted to refugia, and a 0% probability that it would be extirpated (FEMAT Table IV-22).

Management within LSRs was considered to have potential negative impacts to the species.

B. Major Habitat and Viability Considerations

Maintaining refuge sites with appropriate microclimate conditions during the summer and winter within and around occupied habitat is considered critical. Retaining large woody debris, leaf litter, uncompacted soil, and canopy cover may assist in maintaining summer shade and refuge sites with respect to these habitat conditions. The range of environmental conditions that these species can tolerate is not known. Desiccation is the most common cause of mortality for mollusks in general.

The number of population sites required to maintain species viability is unknown, however, it can be assumed that the likelihood of species viability increases with the number of populations.

C. Threats to the Species

Given that little information is available about the habitat needs of the species, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities which increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means (including fire, herbicide use, recreation development), over-collecting, and disturbance during aestivation may constitute a major threat to this species. Road-building and road maintenance have been identified as specific threats (J-2, p. 323)

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D. Distribution Relative to Land Allocations

Most of the species' range is on non-federal land within the Columbia River Gorge National Scenic Area.

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The management goal for this species is to maintain the species across the known range by avoiding actions that would degrade occupied habitat or adversely impact the viability of existing populations.

B. Specific Objectives

- Maintain uncompacted soil in and near populated sites.
- Maintain undisturbed talus and rocky outcrops (most important in the lower third of the slope).
- Maintain vegetative community and shading in the population area.
- Maintain current volume of coarse woody debris as food sources (substrate for fungi) and refuge sites, and protect future sources of coarse woody debris.
- Maintain soil temperature and moisture regime of the refugia sites (cool and moist during the summer).

IV. HABITAT MANAGEMENT

A. Lessons from History

Knowledge of the species range and habitat requirements is likely to change, as there has been little to no field research outside of the known localities. Over-collecting has led to the extirpation of many species in Hawaii (Hadfield 1986), and caution should be exercised when surveying for this species in order to ensure that the activities do not inadvertently extirpate populations. Fire management activities that increased the intensity, duration, or frequency of fire, forest management activities that affect shade, as well as road construction and rock-removal that directly disturbed have significantly impacted other *Monadenia* species in the Pacific Northwest. The use of talus in the construction of dams in the Columbia Gorge is considered to have had a significant impact on individual populations of this species (J-2, p. 323).

B. Identification of Habitat Areas for Management

As of August 1998, it is considered important to protect all known sites on public lands due to the relative rarity of these subspecies. The Habitat Area will be identified as the area around known site locations that includes all habitat features, which contribute to environmental conditions important to the species at the known site. In most cases, this could be achieved by areas up to tens of acres (ROD C-5). As new data is compiled, consideration should be given to daily and annual movements within the life cycles of the organisms.

C. Management Within Habitat Areas

In general, manage populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi.

- maintain undisturbed talus and vegetative cover
- manage adjacent forested areas to provide shade, coarse woody debris, and uncompacted forest litter
- protect sites from wildfire events due to the rarity of known populations
- protect flows from adjacent springs to maintain the mositure regime

D. Other Management Issues and Considerations

Consideration should be given to locating and managing additional sites and determining the actual biogeography of the species.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

Current knowledge of this species is limited, and is not based on long-range or site specific studies. Significant data gaps exist in our knowledge of the species' fossil record and its biologic and environmental needs. The species' current and former distribution, and the factors that have controlled distribution, diet, reproductive rates, and dispersal rates need further investigation. Local and range-wide population trends are not known.

Field research associated with any mollusk species often results in detections in different habitats than expected based on prior knowledge. Range extensions are also common. Surveys outside of known habitat conditions may be helpful in determining the full range of habitat conditions in which the organisms can survive.

B. Research Questions

- What are the food requirements of these species, and are any of these food requirements unique to the species?
- What is the range of environmental conditions that this species can tolerate, and how long can extremes be tolerated?
- Are there other populated sites?
- What factors control the species' rate and distance of dispersal?
- What is the species' natural life span?
- What is the actual physical range of the species?
- How far does an individual range away from its refuge site?
- What is the population density of the known sites?

C. Monitoring Needs and Recommendations

Known sites on public land should be monitored to assess population trends and to attempt to determine the factors which control those trends. Monitoring strategies should be designed to assist in determining if the implementation of the plan is resulting in the protection of habitat for these subspecies. In addition, monitoring should be designed to ensure that site disturbance or collection activities do not extirpate local populations.

VI. REFERENCES

Appendix J2. 1994. Final Supplemental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl., Appendix J2, Results of Additional Species Analysis. USDA Forest Service and USDI Bureau of Land Management, i-viii, 476 p.

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SECTION NO. 10

Monadenia fidelis ochromphalus **Yellow-base Sideband**

Monadenia fidelis klamathica **Oak flat or Klamath Sideband**

Draft Management Recommendations
for
Monadenia fidelis ochromphalus, the Yellow-base Sideband
and
Monadenia fidelis klamathica, the Oak flat or Klamath Sideband]

Version 2.0

by

Ted R. Weasma

January 1999

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EXECUTIVE SUMMARY

Species: *Monadenia fidelis ochromphalous* (Yellow-base Sideband)
Monadenia fidelis klamathica (Oak Flat or Klamath Sideband)

Taxonomic Group: Mollusk (Mollusca) Snail (Gastropoda) Land Snail (Pulmonata)

ROD Components: Standard and Guidelines C-6, Protect from Grazing.

Other Management Status: None identified at this time.

Range: Both subspecies are known from the Klamath National Forest in Siskiyou County, California and the Trinity National Forest in Humboldt County. The existing and suspected ranges for the two subspecies are based on very limited data. *Monadenia fidelis klamathica* is known from 11 known sites in three small areas collected in the 1930s and one in the Salmon River drainage collected in the early 1950s. *Monadenia fidelis ochromphalus* seems to have been last found in the early 1960s. It is known from 39 sites and over a broader area than *M. fidelis klamathica*.

Specific Habitat: Both subspecies are found in stable riparian zones within semi-dry mixed deciduous and conifer forests, but are not necessarily restricted to riparian zones. Late-successional forest with high canopy closure and large down woody debris or rock talus is considered to be optimal habitat. Abundance is unknown but, based on the limited number of known sites and specimens collected, both are expected to be rare.

Threats: In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities that increase temperature, decrease moisture, or decrease food supplies available in populated sites. Since most of the known sites for these species occur in areas withdrawn from timber harvesting, habitat alteration resulting from grazing is the most significant threat identified in the ROD.

Management Recommendations: Mitigation measures outlined in Appendix J-2 stress the importance of assessing the adequacy of Riparian Reserves and protecting sites from grazing. In general, manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Adjacent forested areas should be managed to provide shade, coarse woody debris, and uncompacted forest litter.

Information Needs: Present knowledge of these subspecies is based on limited collecting, all of which occured prior to the early 1960s. The historic known sites need to be reverified. There is also some question as to the taxonomic status of *Monadenia fidelis klamathica*. Significant data gaps exist in our knowledge of the subspecies' environmental needs. The present and former distribution, and the factors that have controlled distribution, diet, reproductive rates, and dispersal rates need further investigation.

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Both of the species considered in this management recommendation are described as subspecies of *Monadenia fidelis*. The description of this species is based on a shell first considered to be *Helix fidelis* Gray, 1834, Proc. Zool. Soc., p. 67 (no locality); Newcomb, 1865, Amer. Journ. Conch., 1: 342, 350; Binney and Bland, 1869, L. & Fr. W. Sh. N. A., 1: 161, fig. 278; Cooper, 1868, Amer. Journ. Conch., 4: 229-239.

Subsequent authors have described this species as:

1. *Helix nuttalliana* Lea, 1839, Trans. Amer. Phil. Soc. 6: 88, pl. 23, fig. 74 (Fort Vancouver to the Ocean); A. Binney, 1851, Terr. Moll., 2: 159, pl. 18.

2. *Helix oregonensis* Lea, 1839, Trans. Amer. Phil. Soc. 6: 100, pl. 23, fig. 85 (Wahlamat near junction with Columbia R.). Not Lea, 1866, Journ. Acad. nat. Sci. Phila., (2), 6: 155 (Point Cypress, Cal.). *Cf* Edson, 1912, Nautilus, 26: 49: Hanna 1922, Nautilus, 36: 12; and Henderson, 1936, Univ. Colo. Studies, 23: 253.

3. *Monadenia* Pilsbry, 1895, Man. Conch., 9: 198 type *Helix fidelis* Gray.

4. *Aglaia fidelis* Gray, Binney, 1878, Terr. Moll., 5: 350, pl. 18; pl. IX, fig. C, and XIV, fig. E (anatomy); 1885, Man. Amer. L. Sh. p. 121, fig. 90.

5. *Epiphragmophora fidelis* Gray, Pilsbry, 1895, Man. Conch., 9: 198, pl. 59, fig. 81, (gentilia); Randolph, 1899, Nautilus, 13: 25 (variation at Seattle).-Gifford, 1901, Nautilus, 14:144; Whiteaves, 1902, Ottawa Nat., 16:92.-Dall, 1905, Harriman Alaska Exp., 13: 21; Hanna, 1921, Naultilus, 36: 61 (said to eat bird's eggs); Jackson, 1923, Nautilus, 36: 144 (in tree 35 ft. up, Blaine, Ore.).

6. *Monadenia fidelis* Gray, Berry, 1930, Nautilus, 43: 142 (San Juan I.); Chace, 1935, Nautilus, 46: 142 (Endert's Beach); Cockerell, 1935, Nautilus, 49: 35 (living animal, Prairie Creek, Cal.).

Monadenia fidelis ochromphalus and *Monadenia fidelis klamathica* were first described as subspecies of *Monadenia fidelis* by Berry in 1937 [Nautilus 51(1): 28,31].

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B. Species Description

1. Common Characteristics

These 2 subspecies are covered in the same management recommendations because they are closely related taxonomically, they occupy similar ranges and habitats, and they both are listed in the Standards and Guidelines for Protection from Grazing. The two species can be separated by shell characteristics.

2. Morphology

Burch & Pearce (1990) consider the following to be key characteristics for *Monadenia fidelis*.

"Embryonic whorl sculpture irregularly granulose, not papillose; embryonic whorls usually carinate and adult shell may be carinate; spiral color band not far above the shell periphery; shell large; reproductive system with one club shaped mucous gland (Fig. 9.189*b*); . . .". Similar species such as *Helminthoglypta* are not carinate, have radial lines or papillae on the embryonic whorl, increase in size between whorls faster, and have the spiral color band well above the shell periphery. The species are around 30mm in size at maturity.

Monadenia fidelis ochromphalus

Monadenia fidelis ochromphalus is described by Berry (1937) as follows: "Shell similar in general features to typical *fidelis*, but smaller, solid, highly polished, especially on the base, which in some specimens appears more or less dished or reamed out, in others is full and rounded, the umbilicus open and permeable to the apex. Spiral sculpture weak to moderately developed above, very fine and delicate on the base." "Color of shell prevailingly dark, the spire banded, often not too distinctly, with tones varying from deep colonial buff to russet and mars brown; peripheral band wide (2-3 mm.), deep blackish umber, sharply bordered below by a much narrower band of chamois or deep colonial buff; base uniformly a lustrous deep blackish umber excepting the area immediately surrounding the umbilicus, which, together with the umbilical interior, is a strongly contrasting old gold." See Figure 18b in Pilsbry (1939) for a photograph of the shell.

Berry describes the body of *Monadenia fidelis ochromphalus* as follows: "Color of animal: dorsum fawn color to wood brown, more or less heavily suffused darker (bone brown to clove brown) with a light median line on the ridge, sometimes more or less maculated, the tail consistently paler; sole buffy brown to grayish olive, widely margined fuscous to fuscous-black."

Monadenia fidelis klamathica

Berry (1939) describes *Monadenia fidelis klamathica* as follows: "Shell of but moderate size and heaviness, low-conic or low pyramidal-conic, umbilicate; the umbilicus steep-walled, distinctly permeable to apex, and having a maximum diameter in the type specimen of about one-ninth the major diameter of the shell, but in other specimens usually narrower (1/12 to 1/14 the diameter of the shell). Whorls about 6-1/4 or a trifle less, convex, the last with the superior portion distinctly descending in front. Aperture ovate, somewhat flattened below, and deflected from the vertical axis about 48E. Peristome sinuous, distinctly everted below and especially at the umbilicus, the outline of which thus becomes materially indented, but only slightly expanded on the upper segment; the edges converging and connected by a thin but evident callus."

"Surface of first 1-3/4 turns densely and closely set with diamond-shaped papillae usually eroded in mature shells, separated by narrow groves, of which the obliquely descending are rather more distinct than the obliquely ascending ones, but the arrangement not always wholly regular. Lines of growth absent or difficult to make out on the first turn and a half, but quite strong on the succeeding quarter turn, after which the diamond-shaped papillation abruptly ceases, but the growth wrinkles, becoming further accentuated, are henceforth the dominant periostracal ornamentation. Surface of main portion of [the] shell smooth and polished, unsculptured both above and below save for the lines of growth and a very finely incised almost microscopic spiral striation."

"Color a much richer and darker chestnut brown, or a glossy light seal brown on the spire, and with a conspicuous tri-colored band bordering the periphery, the dark central stripe of about 2.5 mm thickness being approximately the color of the base of the shell and in rich contrast to the stripe just below it which is of a thickness of 1.5 mm, and is ochraceous buff to yellow ochre in color. The uppermost band of hazel is slightly narrower than the lowermost and less conspicuous."

Berry considers the following to be distinctive characters ". . . the comparatively small size, low-conic form, polished surface, and rich dark coloring, set off by the bright ochraceous banding." See figure 19 in Pilsbry (1939) for a photograph of the shell.

Soft body characteristics are not published for *Monadenia fidelis klamathica*.

Note that the color descriptions above are from a 1920s color key that is no longer available and the color patches were not made with stable inks so existing copies will not match.

3. Reproductive Biology

These subspecies live for at least several years and are probably sexually active in the fall with the young hatching in the spring. Egg masses are probably white, laid in small hollows in the soil under cover, and may consist of as many as 120 eggs, with more than one clutch in a season. Data describing the anatomical characteristics of the reproductive organs, have not been published for these subspecies. All *Monadenia* have a reproductive system with a dart and a single tubular mucus gland apparatus associated with or in close proximity to the vagina (Miller and Naranjo-Garcia 1991). Species of this genus are hermaphroditic and may copulate continuously for more than 23 hours.

Loose soil is necessary for egg laying.

4. Ecology

During the summer both subspecies are partially arboreal, and can be found on trees below a moss layer or under large woody debris, which serve as refuge from desiccation. During wet seasons both may be on the ground foraging for green vegetation and fruit, feces, animal remains, old leaves, leaf mold, and woody debris. It is possible that they may also graze on arboreal lichens as with similar species (personal communication, Roth, May 1996).

The species probably have a digestive efficiency rate in the high forties for assimilation of food materials, a low rate that results in the viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, snails and slugs represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active. Birds, beetles, shrews, mice, raccoons, carnivorous mollusks, and snakes are likely predators. Species of *Vespericola*, *Helminthoglypta*, and *Haplotrema* commonly occur in the same areas as *Monadenias*.

C. Range, Known Sites

The existing and suspected ranges for the two subspecies is based on very limited data. *Monadenia fidelis klamathica* is only known from 11 known sites in 3 small areas collected in the 1930s and one in the Salmon River drainage collected in the early 1950s. The **Type Locality** for *Monadenia fidelis klamathica* is along Oak Flat Creek, near the Klamath River, Siskiyou County,

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California. It is also known from Orleans, California, in the Happy Camp area, and up the Salmon River a few miles from its junction with the Klamath River.

Monadenia fidelis ochromphalus seems to have been last found in the early 1960s. It is known from 39 sites and over a broader area than *M. fidelis klamathica*. Berry identifies the **Type Locality** for *Monadenia fidelis ochromphalus* as Etna Creek, about 2½ miles above Etna, Siskiyou County, California. Other populations have been identified in the Marble Mountain Wilderness and down the Klamath River Drainage.

Monadenia fidelis klamathica is suspected as far south as the Hoopa Valley Indian Reservation, California and as far north as Josephine and Jackson counties, Oregon. It is not suspected east of the Sacramento drainage and is not likely west in coastal areas. *Monadenia fidelis ochromphalus* is suspected to have a similar range to that suspected for *Monadenia fidelis klamathica* but could range farther to the east in Siskiyou County where it may overlap with the range of *Monadenia chaceana*.

D. Habitat Characteristics and Species Abundance

Both subspecies are found in stable riparian zones within semi-dry mixed deciduous and conifer forests, but are not necessarily restricted to riparian zones. Late-successional forest with high canopy closure and large down woody debris or rock talus is considered to be optimal habitat. *Monadenia fidelis ochromphalus* has been found on leaves and sticks, on concrete walls of an irrigation ditch, and on mossy boulders and stones. *Monadenia fidelis klamathica* has been found under logs, in rocky areas, and on pine needle and live oak leave litter. Forest litter in the semi-dry areas inhabited by these species is considered to be an important habitat component. These species are tolerant of drier conditions than most *Monadenia fidelis* subspecies but not as adapted to dry conditions as *Monadenia chaceana* or *Monadenia troglodytes*.

No specimens have been found for many years, except for *M. f. klamithica* that was collected from the type locality in 1998 by the author. The abundance of either subspecies is unknown, but based on the limited number of known sites and specimens collected, both are expected to be rare.

II. CURRENT SPECIES SITUATION

A. Why Species is not listed under Survey & Manage Standards & Guidelines

According to the FEMAT report, the mollusk assessment suggests that the options considered in the outcome assessment were less effective in providing for mollusks than for any other species group. High degrees of endemism, rareness, and habitat specialization account, in part, for the low ratings. Under the selected management option (Option 9) for *M. fidelis klamathica*, there would be a 23% probability that the species would be well-distributed across Federal lands, a 27% probability that the species would remain viable but with gaps in distribution, a 33% probability that populations would be restricted to refugia, and a 17% probability that it would be extirpated. For *M. fidelis ochramphalus*, outcomes were assessed at a 40% probability that the species would be well-distributed across Federal lands, a 30% probability that the species would remain viable but with gaps in distribution, a 20% probability that populations would be restricted to refugia, and a 10% probability that it would be extirpated. (FEMAT Table IV-22).

The extreme rarity of both subspecies greatly influenced the risk assessments. The strong association with riparian zones and the land use allocation of the Federally-owned sites in which they are known or suspected to occur (Wilderness Area or LSR) indicated that there was no identifiable risk from timber management. Grazing in riparian zones was, therefore, identified as the remaining significant risk to both subspecies.

B. Major Habitat and Viability Considerations

Maintaining refuge sites with appropriate microclimate conditions during the summer and winter within and around occupied habitat is considered critical. Retaining large woody debris, leaf litter, uncompacted soil, and canopy cover may assist in maintaining summer shade and refuge sites with respect to these habitat conditions.

The survival of mollusk species in semi-xeric (dry) conditions is especially dependent upon the presence of adequate refuge sites during the hot summer and cold winter months. An increase in temperature or decrease in moisture during the hot summer months is much more likely to adversely affect these subspecies than those that live in a mesic (moist) environment. The range of environmental conditions that these species can tolerate is not known. Desiccation is the most common cause of mortality for mollusks in general. These subspecies are expected to be less xeric tolerant than *Monadenia churchi* or *Monadenia chaceana* and so even less tolerant to degraded habitat conditions.

The number of population sites required to maintain species viability is unknown; however, it can be assumed that the likelihood of species viability increases with the number of populations.

C. Threats to the Species

Given that little information is available about the habitat needs of the species, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities that increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means (including fire, herbicide use, recreation development), over-collecting, and disturbance during aestivation may constitute major threats.

The two subspecies' very small known range and close association with riparian zones further suggests that habitat alteration, which would result in a decrease of existing shade, woody debris and leaf litter, increased soil compaction, or major flood events by either human or natural means, might constitute specific threats to the species. Grazing activities that remove vegetative cover and compact the soil are of greatest concern. Disturbance of refuge areas by grazing animals during the aestivation periods is likely to cause mortality.

D. Distribution Relative to Land Allocations

Monadenia fidelis klamathica has been found on private lands and within the Siskiyou Wilderness. There is a known site within a riparian corridor on Federal land in a Matrix land use allocation. *Monadenia fidelis ochromphalus* has been found within a Late-Successional Reserve, a Wilderness area, and on private land.

Distribution relative to private land was identified in Appendix J-2 as a Cumulative Effects concern for *M. fidelis ochromphalus*, but not for *M. fidelis klamathica*.

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The management goal for this species is to maintain the species across the known range by avoiding actions that would degrade occupied habitat or adversely impact the viability of existing populations.

B. Specific Objectives

Since these subspecies are currently only listed under the Standards and Guidelines for Protection from grazing, the following objectives apply only as they relate to impacts resulting from grazing.

- C Maintain uncompacted soil in and near populated sites.

- Maintain the vegetative community shading the population area. Hardwood retention and enhancement (an increase in alders or maples) would provide additional food and shelter. Shrubs and grasses are also important for cover and food.

- Maintain current volume of coarse woody debris as food sources (substrate for fungi) and refuge sites and protect future sources of coarse woody debris.

- Maintain soil temperature and moisture regime of the refugia sites (cool and moist during the summer).

IV. HABITAT MANAGEMENT

A. Lessons from History

Knowledge of the species' range and habitat requirements is likely to change. Based on paleontological evidence and general malacological knowledge, the historical range of these and most Northwest species was more extensive than that indicated by the known sites. Over-collecting has led to the extirpation of many species in Hawaii (Hadfield 1986), and caution should be exercised when surveying for this species in order to ensure that the activities do not inadvertently extirpate populations. Fire management activities that increased the intensity, duration, or frequency of fire; forest management activities that affected shade; and road construction that directly disturbed sites have significantly impacted other *Monadenia* species in the Pacific Northwest.

B. Identification of Habitat Areas for Management

As of August 1998, it is considered important to protect all known occupied sites on public lands due to the relative rarity of these subspecies. The Habitat Area will be identified as the area around known site locations, which includes all habitat features, that contribute to environmental conditions important to the species at the known site. In most cases, this could be achieved by areas up to tens of acres (ROD C-5). As new data is compiled, consideration should be given to daily and annual movements within the life cycles of the organisms.

C. Management Within Habitat Areas

Mitigation measures outlined in Appendix J-2 stress the importance of assessing the adequacy of Riparian Reserves and protecting sites from grazing. In general, prohibit grazing within Habitat Areas in order to provide the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Forested areas around discovery sites should be protected from grazing to provide shade, coarse woody debris, and uncompacted forest litter.

D. Other Management Issues and Considerations

Maintenance of interconnecting riparian zones with suitable habitat between populated and potential sites may facilitate dispersal and recolonization and gene-pool mixing. Special Forest Product harvest, such as moss removal or mushroom harvesting, may lead to extensive habitat alteration in known site areas. Prescribed fire may be considered as a tool to be used outside of Habitat Areas to reduce the risk of catastrophic natural fire. Prescribed burning should be designed to avoid significant impacts to the habitat conditions in the Habitat Area as outlined in Section II-B.

Consideration should be given to locating and managing additional sites and determining the actual biogeography of the species.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

Present knowledge of these subspecies is based on limited collecting, all of which occurred prior to the early 1960s. The historic known sites need to be reverified. There is also some question as to the taxonomic status of *Monadenia fidelis klamathica*. Significant data gaps exist in our knowledge of the subspecies' fossil record and its biologic and environmental needs. The present and former distribution, and the factors that have controlled distribution, diet, reproductive rates, and dispersal rates need further investigation. Local and range-wide population trends are not known.

Field research associated with any mollusk species often results in detections in different habitats than expected based on prior knowledge. Range extensions are also common. Surveys outside of known habitat conditions may be helpful in determining the full range of habitat conditions in which the organisms can survive.

B. Research Questions

- What are the food requirements, and are any of these food requirements unique to the subspecies?

C What is the range of environmental conditions that can be tolerated, and how long can extremes be tolerated?

- Are there other populated sites?

- What factors control the rate and distance of dispersal?

- What is the subspecies' natural life span?

- What adaptations have these subspecies made that allow them to be more xeric tolerant than other *Monadenia* subspecies?

- What is the actual physical range of the subspecies?

- How far does an individual range away from its refuge site?

C. Monitoring Needs and Recommendations

Known sites on public land should be monitored to assess population trends and to attempt to determine the factors that control those trends. Monitoring strategies should be designed to assist in determining if the implementation of the plan is resulting in the protection of habitat for these subspecies. In addition, monitoring should be designed to ensure that site disturbance or collection activities do not extirpate local populations.

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SECTION NO. 11

Monadenia (Shastelix) troglodytes troglodytes Shasta Sideband

Monadenia (Shastelix) troglodytes wintu Wintu Sideband

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Draft Management Recommendations
for
Monadenia (Shastelix) troglodytes troglodytes, Shasta Sideband
and
Monadenia (Shastelix) troglodytes wintu, Wintu Sideband (land snails)

Version 2.0

by

Ted R. Weasma

January 1999

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EXECUTIVE SUMMARY

Species: *Monadenia (Shastelix) trolodytes troglodytes* (Shasta sideband)
Monadenia (Shastelix) troglodytes wintu (Wintu sideband)

Taxonomic Group: Mollusk (Mollusca) Snail (Gastropoda) Land Snail (Order Pulmonata)

ROD Components: Survey and Manage Strategies 1 & 2

Other Management Status: None identified at this time.

Range: As of August 1998, the known range for *Monadenia troglodytes troglodytes* is defined by 10 sites along the McCloud River Arm of Shasta Lake in Shasta County, California. The known range for *Monadenia troglodytes wintu* is known from 7 sites, also around Shasta Lake in Shasta County, California but it is more commonly found nearer the Pit River Arm. Both species are suspected to be found in other limestone areas to the west.

Specific Habitat: Habitat information is based on the limited number of known sites as outlined above. Both of these subspecies have been found to be associated with limestone substrates, where they occupy caves, talus slopes, and other rocky areas that are open, brush covered, or associated with pine-oak woodlands. The lower one third of a talus slope generally contains the largest and most stable habitat elements. Mollusks, which inhabit talus slopes, also utilize the surrounding forest areas during moist, cool conditions.

Threats: Given that little information is available about the habitat needs of these subspecies, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities that increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means (including fire, herbicide use, recreation development), over-collecting, and disturbance during aestivation may constitute major threats to this species. Road building and road maintenance have been identified as specific threats to both subspecies.

Management Recommendations: Manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Adjacent forested areas should be managed to provide shade, coarse woody debris, and uncompacted forest litter. Due to the rarity of known populations, sites should be protected from wildfire events.

Information Needs: Information is needed on the actual range of the species, the location of other populations, the stability of the known populations, and the factors that control population stability.

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I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

The genus *Monadenia* was first considered to belong to the genus *Aglaia* in part (Von Martens 1860; Die Heliceen, p. 122; Binney 1869; L. & W. Sh. N. A. 1:161, 1878. Terr. Moll., 5, in Bull. Mus. Comp. Zool., 4: 350.). It became *Aglaja* according to Binney's work in 1890 (Bull. Mus. Comp. Zool., 19: 213. Not *Aglaja* Albers, 1850, nor of Reiner. 1804).

The genus *Monadenia* was established by Pilsbry in 1895 (Man. Conch., 9: 198) with *Helix fidelis* Gray established as the type for this new genus.

The species *Monadenia troglodytes* was first described by Hanna & Smith in 1933 (Nautilus, 46: 84, pl. 5, figs. 6-8). Up to this point no living specimens had been discovered.

Roth in 1981 established the 2 subspecies *Monadenia (Shastelix) troglodytes troglodytes* and *Monadenia (Shastelix) troglodytes wintu* based on distinct anatomical differences noted in living specimens that had recently been discovered.

B. Species Description

1. Common Characteristics

These 2 subspecies of *Monadenia troglodytes* are covered in the same management recommendation because they occupy similar ranges and habitats (the subspecies were not formally recognized until 1981).

2. Morphology

Burch & Pearce (1990) consider the following to be key characteristics for *Monadenia*. "Embryonic whorl sculpture irregularly granulose, not papillose; embryonic whorls usually carinate and adult shell may be carinate; spiral color band not far above the shell periphery; shell large; reproductive system with one club shaped mucous gland (Fig. 9.189*b*); . . .". Similar species such as *Helminthoglypta* are not carinate, have radial lines or papillae on the embryonic whorl, and have the spiral color band well above the shell periphery.

Hanna & Smith, (1933) describe *M. troglodytes* as follows: "Shell light buff, medium size, widely umbilicate; spire greatly depressed; whorls 5 ½ with moderately deep suture; the last whorl slightly depressed near the aperture; outer margin expanded very little, the basal margin somewhat more so; one narrow pale brown spiral band appears just above the periphery, which is bounded above and below by white bands that are slightly wider; surface without markings except growth lines; nucleus consisting of 1 ½ whorls marked by radiating wavy riblets. Diameter 24.2; altitude 10.8 mm."

They recognize the depressed spire and a wider umbilicus as distinctive enough to separate *M. troglodytes* from *M. mormonum*.

Roth (1996) gives the following key characteristics: "Diameter 20.6 - 29.3 mm. Shell solid, depressed, with 5.0 - 6.1 whorls. Spire low, its sides weakly convex; whorls 1.5 - 1.9, nuclear tip smooth, followed by fine granulation tending to form wavy radial riblets below suture; granules elsewhere spirally elongated, in diagonal series or irregularly scattered. Post-embryonic sculpture of increasingly sparse papillation, disappearing by third or fourth whorl. Body whorl with fine growth rugae and microscopic, wavy, parallel, incised striae, most evident behind lip. Aperture broadly ear-shaped, oblique. Lip turned outward, reflected, and thickened by callus. Inner lip impinging slightly on umbilicus. Umbilicus contained 5-11 times in diameter. Ground color white or light tan; spire and shoulder reddish brown, usually with darker radial st[r]eaks, sometimes tan with single or double narrow brown stripes. Peripheral band strong. Base whitish to reddish brown. Periostracum smooth, colorless or light yellowish tan. Animal gray to sooty black with reddish or purplish cast, darker on the dorsum, with a light mid-dorsal stripe. Mantle over lung translucent buff, with gray penciling covering less than 10% of surface. Atrium and dart sac large. Epiphallic caecum longer than penis plus ephiphallus, borne in 4 - 7 helical coils. Verge cylindrical to ovate-conic, with slitlike lateral meatus on anterior edge; dorsal facet concavely beveled, fitting against single large pilaster on wall of penal chamber."

The 2 subspecies can be separated by shell characteristics. According to Roth, 1996, *M. troglodytes troglodytes* tends to be low spired with a relatively broad umbilicus and a light translucent shell. *M. troglodytes wintu* is, on the average, larger and higher spired. The shell is more highly colored when one compares the 2 species together on an opaque white background.

Soft body anatomy appropriate for use in field identification work is discussed above. Roth (1996) reports that *M. troglodytes wintu*'s epiphallus tends to have more coils than that of *M. troglodytes troglodytes*.

3. Reproductive Biology

Data have not been published on the reproductive biology of these species. All *Monadenia* have a reproductive system with a dart and a single tubular mucus gland apparatus associated with or in close proximity to the vagina (Miller and Naranjo-Garcia, 1991). Species of this genus are hermaphroditic and may copulate continuously for more than 23 hours. The species lay eggs (several 10s), are likely to live 6+ years, and probably mature in 2 years (pers. comm. B. Roth, 1996). Roth also reports that a captive specimen laid eggs in soil in December and by January he was able to count 24 hatchlings. A month later he counted 32 juveniles. Loose soil is considered to be necessary for egg laying.

4. Ecology

During the summer, both subspecies will be found under rocks in stable, moist substrates that serve as refuge sites from desiccation. The low, flat profile of the shells of these animals is an adaption that allows them to penetrate narrow crevices between and under rocks in otherwise hostile environments. Their light shell color also reflects solar radiation and may provide some protection from heat when exposed during the summer. During the wet seasons, they may be found away from refugia, foraging for green vegetation and fruit, feces, old leaves, leaf mold, and fungi. Mollusks, which inhabit talus slopes, utilize the surrounding forest areas during moist, cool conditions, ranging out from the refugia provided by the rocks to forage in the adjacent forest floor litter. Vegetation within the surrounding forest not only moderates the temperature and moisture conditions within the rock habitats, but provides food, loose soil, and litter conditions necessary for egg laying.

Generally, the lower one third of a talus slope contains the largest, most stable habitat elements. Because of the long-term stability in these areas and larger interstitial spaces between the rocks, microsite conditions are more favorable and provide dependable refugia sites. It is important, therefore, to avoid disturbance of the bottom of the slope that could result in loss of these refugia areas and destabilizion of the entire talus field.

Both subspecies probably have an efficiency rate in the high forties for assimilation of food materials, a low rate that results in the dispersal of intact fungal spores and hyphae. Birds, beetles, shrews, mice, raccoons, carnivorous mollusks, and snakes are likely predators. The species are crepuscular (active only during dawn and dusk during the spring and fall seasons). Species of *Vespericola, Helminthoglypta, Trilobopsis, and*

Haplotrema commonly occur in the same geographic area as *Monadenias*.

C. Range, Known Sites

The known range for these species is based on limited data and is likely an artifact of collecting that occurred at most sites in the 1970s. These species are local endemics in Shasta County, California. *M. troglodytes troglodytes* is known from 10 sites along the McCloud River Arm of Shasta Lake, ranging in elevation from 330 m. (1100 ft.) to 760 m. (2500 ft.). One site is located near the Pit River Arm of Shasta Lake. The **Type Locality** for *M. troglodytes troglodytes* is Samwel Cave. *M. troglodytes wintu* has a range along the Pit River Arm of Shasta Lake and south of the lake, known from 7 sites. The **Type Locality** for *M. troglodytes wintu* is a cave between 2 limestone buttes at the south end of Gray Rocks, above the Pit River Arm of Shasta Lake. The species are suspected to exist in limestone areas to the west. For specific sites, refer to the Survey and Manage database.

D. Habitat Characteristics and Species Abundance

Few populated sites are known. *M. troglodytes troglodytes* and *M. troglodytes wintu* seem to be restricted to limestone outcrops or related substrates, and are associated with caves, talus, or rocky outcrops in open, brushy, and late-seral pine-oak woodland areas. Rocks and large woody debris can serve as refugia during the summer and late winter seasons. Forest litter and coarse woody debris in the semi-dry areas in which these species occur is considered necessary to provide food (shelter and substrate for fungi) and temporary cover when foraging.

Abundance is unknown at populated sites.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage

According to the FEMAT report, the mollusk assessment suggests that the options considered in the outcome assessment were less effective in providing for mollusks than for any other species group. High degrees of endemism, rareness, and habitat specialization account, in part, for the low ratings. Under the selected management option (Option 9) for both subspecies, there would be a 33% probability that the species would be well-distributed across Federal lands, a 37% probability that the species would remain viable but with gaps in distribution, a 17% probability that populations would be restricted to refugia, a 17% and a 13% probability that it would be extirpated (FEMAT Table IV-22).

Major considerations for both subspecies were the small number of known sites, and that known sites are outside of Riparian Reserves and LSRs under Option 9.

B. Major Habitat and Viability Considerations

Limestone areas that include caves, talus slopes, and other rocky areas, which are open, brush-covered, or associated with pine-oak woodlands, are the known habitats for these subspecies. Maintaining refuge sites with appropriate microclimate conditions during summer and winter within and around occupied habitat is considered critical. Retaining large woody debris, leaf litter, uncompacted soil, and canopy cover may assist in maintaining summer shade and refuge sites with respect to these habitat conditions. Data is not presently sufficient to determine the temperature and moisture range through which the species can survive, but desiccation is the most common cause of mortality for mollusks in general.

The number of population sites required to maintain species viability is unknown; however, it can be assumed that the likelihood of species viability increases with the number of populations.

C. Threats to the Species

Given that little information is available about the habitat needs of the species, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities that increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means (including fire, herbicide use, recreation development), over-collecting, and disturbance during aestivation may constitute major threats to these species.

The survival of mollusk species in semi-dry (closer to dry than moist) environments is especially dependent on having adequate refuge during the hot summer and cold winter months. An increase in temperature or decrease in moisture during the hot summer months is much more likely to adversely affect these species than those that live in a moist environment.

Road building and road maintenance have been identified as a specific threat to both subspecies (FSEIS, Appendix J-2, pp. 329 -331).

D. Distribution Relative to Land Allocations

M. troglodytes troglodytes is known from matrix lands, but not in LSRs (Late-Successional Reserves) and is, therefore, not protected by current federal land allocations. *M. troglodytes wintu* is mostly within a federal administrative withdrawal area.

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The management goal for these subspecies is to maintain the subspecies across the known range by avoiding actions that would degrade occupied habitat or adversely impact the viability of existing populations.

B. Specific Objectives

- Maintain uncompacted soil in and near populated sites.

- Maintain undisturbed talus and rocky outcrops (most important in the lower third of the slope).

- Maintain vegetative community and shading in the population area.

- Maintain current volume of coarse woody debris as food sources (substrate for fungi) and refuge sites, and protect future sources of coarse woody debris.

- Maintain soil temperature and moisture regime of the refugia sites (cool and moist during the summer).

IV. HABITAT MANAGEMENT

A. Lessons from History

M. troglodytes was historically only known from Samwel Cave and was thought to be extinct. Further research located new populations, and the species was later split into 2 subspecies. Knowledge of the species' range and habitat requirements is likely to change, as there has been little to no field research outside of the area around Shasta Lake. Over-collecting has led to the extirpation of many species in Hawaii (Hadfield 1986), and caution should be exercised when surveying for this species in order to ensure that the activities do not inadvertently extirpate individuals or populations of this species. Fire management activities that increased the intensity, duration, or frequency of fire, and forest management activities that directly affected shade and stability, including road construction and road maintenance, have significantly impacted other mollusk species in the Pacific Northwest.

B. Identification of Habitat Areas for Management

As of August 1998, it is considered important to protect all known occupied sites on public lands due to the relative rarity of these subspecies. The Habitat Area will be identified as the area around known site locations including all habitat features that contribute to environmental conditions important to the species at the known site. In most cases, this could be achieved by areas up to tens of acres (ROD C-5). As new data is compiled, consideration should be given to daily and annual movements within the life cycles of the organisms.

C. Management Within Habitat Areas

In general, manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Adjacent forested areas should be managed to mitigate for the drying effects of wind and to provide shade, coarse woody debris, and uncompacted forest litter. Due to the rarity of known populations, sites should be protected from wildfire events.

Recreational activities around Samwel Cave and the trails to Samwel Cave should be managed in accordance with habitat conditions for management areas as outlined in Section II-B.

D. Other Management Issues and Considerations

Prescribed fire may be considered as a tool to be used outside of Habitat Areas to reduce the risk of catastrophic natural fire. Prescribed burning should be designed to avoid significant impacts to the habitat conditions in the management area as outlined in Section II-B.

Consideration should be given to locating and managing additional sites and determining the entire range of the species.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

Present knowledge of these subspecies is based on limited collecting from known population areas in the 1930s and the 1970s. Due to significant data gaps, the species' biological and environmental needs are not well known. The species' present and former distribution, and the factors that have controlled distribution, diet, reproductive rates, and dispersal rates need further investigation. Local and range-wide population trends are not known.

Field research associated with any mollusk species often results in detections in different habitats than expected based on prior knowledge. Range extensions are also common. Surveys outside of known habitat conditions may be helpful in determining the full range of habitat conditions in which the organisms can survive.

B. Research Questions

- What are the food requirements of these species, and are any of these food requirements unique to the subspecies?
- What is the range of environmental conditions that these subspecies can tolerate, and how long can extremes be tolerated?
- Are there other populated sites?
- What factors control the species' rate and distance of dispersal?
- What is the species' natural life span?
- What adaptations have the species made that allows it to be more xeric tolerant then most *Monadenia*?
- What is the actual physical range of the species?
- How far does an individual range away from its refuge site?
- What is the population density of the known sites?

C. Monitoring Needs and Recommendations

Known sites on public land should be monitored to assess population trends and to attempt to determine the factors that control those trends. Monitoring strategies should be designed to assist in determining if the implementation of the plan is resulting in the protection of habitat for these subspecies. In addition, monitoring should be designed to ensure that site disturbance or collection activities do not extirpate local populations.

VI. REFERENCES

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SECTION NO. 12
Oreohelix n. sp.
Chelan Mountainsnail

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Management Recommendations
for
Terrestrial Mollusk Species
Associated with Dry Forest Habitat

Oreohelix n. sp. 1, Chelan Mountainsnail

V. 2.0

by

Thomas E. Burke

Entiat Ranger District
Wenatchee National Forest

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EXECUTIVE SUMMARY

Species: *Oreohelix* new species 1 (Chelan Mountainsnail)

Taxonomic Group: Mollusk (Phylum Mollusca), (Class Gastropoda)
Land Snail (Subclass Pulmonata; Order Stylommatophora), Mountainsnails (Family Oreohelicidae).

ROD Components: Survey Strategies 1 and 2

Other Management Status: It is a "Bureau Tracking Species" in Washington for the BLM.

Range: The Chelan Mountainsnail is currently known from 14 sites. Of these, seven sites are located in two or three living populations. Before the 1994 Tyee Fire, it is known to have occurred in scattered populations, from an area roughly bordered on the southeast by the Columbia River and following Lake Chelan northwesterly to include the Twentyfive Mile Creek drainage, then southwesterly to Tyee Mountain, then southerly to Chumstick Mountain, and following the ridge southerly and southeasterly to Burch Mountain, then southerly to the confluence of the Wenatchee and Columbia Rivers. This total area of about 70,000 hectares (270 square miles, or 174,000 acres) lies in eastern Chelan County on the Entiat and Chelan Ranger Districts. Future surveys may find it north and/or south of the currently known range.
Specific Habitat: This species has been found in two types of habitats broadly described as: (1) in schist talus, and (2) in litter or under shrubs in and adjacent to open dry forest stands with pinegrass or elk sedge understory. The typical site occurs within concave landforms that accumulate and maintain moisture more efficiently than the surrounding landscape. Elevations range from 365 to 800 meters (1200 to 2600 feet); aspect of the sites is variable. Their foods and range of environmental tolerances are not known, but assumptions on their requirements can be made based on observations of the snails in their habitats.

Threats: The following events or activities in occupied habitats may threaten existing populations of the Chelan mountainsnail:
- Natural habitat disturbances - wildfire, landslides, and floods, which may be aggravated by past management practices.
- Human caused habitat alterations or site disturbances, i.e., talus removal, road construction and maintenance, some logging practices, heavy grazing, off-road vehicle use, and other range management and recreation activities.
- Activities that compact or otherwise disturb the soil, rock, ground cover, or certain vegetation, or which alter temperature or moisture regimes of the habitat.
- Activities that create barriers to dispersal within or between populations within 200 feet.

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Management Recommendations: Protect populations from direct and indirect impacts of fire, herbicide applications, and further habitat degradation or fragmentation. Manage areas of occupied habitat in a manner that will:

- Maintain native grass and sedge cover, and scattered shrubs.
- Maintain overstory cover for maintenance of ground-level temperatures and humidity.
- Maintain natural soil texture, temperature, and moisture.
- Within Habitat Areas, avoid burning, heavy grazing, OHVs, heavy equipment, and other activities that may compact soils or disturb ground cover.
- Retain small and large woody debris, and rocks, including talus.
- Manage adjacent areas as a natural, dry forest biotic community, using hand and mechanical treatments and prescribed burning as appropriate, while protecting occupied habitats from direct burning.
- Avoid further fragmentation of small populations.
- Control noxious weeds, but use herbicides, if needed, only when snails are not on the surface.

Information Needs:

- Where do other populations of the Chelan Mountainsnail occur? How extensive are habitat areas? What is the actual range?
- What amount of connectivity or interaction occurs between sites or populations? What conditions present barriers to interactions within or between populations?
- What are essential habitat components for this species [soil type, pH, temperature, moisture regime, ground cover (i.e., rock, woody debris, litter), canopy cover, specific plants]?
- What are the foods of this species?
- Where are the young deposited; do they require specific conditions to survive?
- Do populations still survive in the sites burned in the Tyee Fire? Will they recover naturally as habitat recovers?
- Is the Twentyfive Mile Creek habitat on Chelan Ranger District intact and supporting the snails following county road reconstruction and maintenance during 1995?
- Since the Chelan Mountainsnail is an undescribed species, would a DNA study assist in clarifying species of *Oreohelix* within the range?

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Phylum: Mollusca	Mollusks
Class: Gastropoda	Snails and Slugs
Subclass: Pulmonata	Air breathing gastropods
Order: Stylommatophora	Terrestrial Pulmonates (most)
Family: Oreohelicidae	Mountainsnails

Oreohelix (*Oreohelix*) n. sp. 1 (new species 1), the Chelan Mountainsnail, was informally recognized by Frest and Johannes (1993, 1995) but has not yet been formally named and described. Being the only *Oreohelix* in the analysis for the Northwest Forest Plan (USDA, Forest Service, and USDI, Bureau of Land Management, 1974), it was simply called *Oreohelix* n. sp. in those and subsequent government documents. However, as Frest and Johannes (1995) have discussed other new species of *Oreohelix*, it would be prudent to retain "n. sp. 1" as the name currently used until a formal name is published.

The species was apparently first reported as "a totally different race . . . ." by Smith (1937, p. 77, cited in Frest and Johannes 1995). Dr. Terrence Frest (Personal communication) rediscovered it in the Twentyfive Mile Creek area near the southwest shore of Lake Chelan, and suggested the common name Chelan Mountainsnail (Frest and Johannes 1993). No type locality has been designated, since the species description has not yet been published.

Pilsbry (1939) had retained the family Camaenidae of Von Mollendorff (1898), but had suggested 2 subfamilies, Ammonitellinae and Oreohelicinae. The family Oreohelicidae, was adopted by C. B. Wurtz in 1955 (Proc. Acad. Nat. Sci. Philadelphia 107:101, cited in Bequaert and Miller 1973).

B. Species Description

1. Morphology

The soft anatomy of the Chelan Mountainsnail has not yet been described. The shell of the species was described by Frest and Johannes (1996 Draft Taxonomic Report, unpublished) as follows:

"Key Characteristics: A medium-sized (to 18 mm diameter) species with up to 4 ½ whorls. Spire moderately tall depressed conic, somewhat as in *Oreohelix variabilis*. Typical two brown color bands are developed; as is common for many *Oreohelix*, the rest of the shell is dirty white; neanic shell surface moderately evenly striate radially throughout, with weak periostracal lirations appearing late on the embryonic shell present on both surfaces (dorsal and ventral) to adulthood. Aperture rounded, not appreciably thickened, and only slightly oblique; last quarter whorl only slightly or not at all deflected; lip not reflected or expanded; parietal callus very thin. Umbilicus (the central hole in the bottom of the shell surrounded by the spiral whorls) moderate in size, about 1/4 shell maximum diameter, deep."

Similar species are primarily other oreohelices. *Oreohelix variabilis* with which Frest and Johannes compared the Chelan Mountainsnail, is an Oregon species, not found in the same area. *Oreohelix junii* occurs in the same area as the Chelan Mountainsnail, and they could be found together. The shape and texture of the shells of these two species differ enough that they can be easily separated. The spire of *O. junii* is distinctly lower. It is more loosely coiled and has a more open umbilicus. The peripheral bands on *O. junii* are often faint or broken. Growth wrinkling on the shell of *O. junii* is apparent but low, the shell being relatively smooth, although with a chalky feel from its highly calcareous content.

Another, apparently undescribed species of *Oreohelix* (the Mad River Mountainsnail) was found within the same range as the Chelan Mountainsnail by Burke in 1996. This snail is similar in shape to *O. junii*, but with very coarse growth wrinkling and spiral striae, and a smaller umbilicus as a result of a more tightly coiled shell.

The range of the Chelan Mountainsnail lies between that of the Yakima Mountainsnail (*Oreohelix* n. sp. 2) of Frest and Johannes (1995), and the Rocky Mountainsnail (*Oreohelix strigosa* Gould, 1846). Although, the ranges of neither of these is known to overlap that of the Chelan Mountainsnail, they more closely resemble it than either of the two species that occur within its range. The Yakima Mountainsnail, ". . . has an angular periphery; is larger, has a smaller umbilicus; and lacks periostracum-fringed lirations" (Frest and Johannes 1996 Draft Taxonomic Report, unpublished). For further comparison with the Yakima Mountainsnail see Frest and Johannes (1995), and for the Rocky Mountainsnail see Pilsbry (1939).

2. Reproductive Biology

Nearly all of the land snails in the Pacific Northwest, including the oreohelices, are hermaphroditic, having both male and female organs. Reproduction in the *Oreohelix* (subgenus *Oreohelix*) is viviparous (more probably ovoviviparous), in which the eggs hatch before leaving the uterus of the parent (Pilsbry 1939; Bequaert and Miller 1973). This is apparently an adaptation to arid climates where small, thin shelled eggs may not survive to hatch.

The following findings have been reported for certain land snails (Tompa et al. 1984), but have not been tested for the oreohelices. Self- fertilization has been demonstrated in some species, although cross- fertilization is the norm. It has been found that some snails, having once mated, will only mate again with a different partner in the near future. The importance of these observations is apparent when considering them as adaptations for survival in small or scattered populations but to avoid or reduce unnecessary inbreeding.

3. Ecology

The following discussion of the genus should be useful when surveying for or noting habitat characteristics of this species:

"They [*Oreohelix* as a genus] are calciphilous [calcium loving], most of them restricted to limestone outcrops and their vicinity." Limestone is usually apparent in the areas where they are found. In the few instances that they were found in the absence of limestone, it was assumed that, ". . . the soil or rock must have contained a fair percentage of lime . . . ." (Henderson and Daniels 1916).

"As a general rule the oreohelices live near the surface, with a single stone, a bit of bark or a few leaves for cover . . . . The opaque whitish and earthy texture of *Oreohelix* shells of the semiarid states is a protective adaptation to the strong light of a high country with little shade. It is a character common to snails exposed to strong insolation all over the world" (Pilsbry 1939:415).

The thick, whitish shell of the oreohelices is apparently an adaptation to arid areas for retaining body moisture and reflecting solar radiation (Hunter 1983). Oreohelices also form an epiphram over the aperture to seal it against water loss. The epiphram is often enhanced by sealing the aperture against the surface of a rock in a cool protected location.

Specifically, habitat of *Oreohelix* n. sp. 1 is in open Douglas-fir plant associations. These snails may be found under the litter of pinegrass or elk sedge, where they apparently find food within the duff layer. What they are eating is not known, but specimens kept for over a year in captivity appeared to regain their vigor when pine grass litter and duff were added to their container.

This species is the only gastropod that inhabits the grassy understory component of the Douglas-fir/pinegrass plant associations where they are found. Although, the small, western glass-snail, *Vitrina pellucida*, is sometimes found among the stems or dead leaves under shrubs near the same sites, ecology of the two species is obviously very different. The relatively large, thick-shelled *Oreohelix* is adapted to the outwardly appearing dry conditions of these sites, where few other animals are found other than arthropods that function as decomposers.

C. Range, Known Sites

Oreohelix n. sp. 1 is a local endemic of the eastern foothills of the Cascade Range in central Washington. Its known range covers about 70,000 hectares (270 square miles, or 174,000 acres) in eastern Chelan County on the Entiat and Chelan Ranger Districts.

Sites of current and past known occurrences are all scattered within an area roughly bounded by the Columbia River on the southeast, and following Lake Chelan northwesterly to include the Twentyfive Mile Creek drainage, then southwesterly to Tyee Mountain, then southerly to Chumstick Mountain, and following the ridge southerly and southeasterly to Burch Mountain, then southerly to the confluence of the Wenatchee and Columbia Rivers.

Within this area this snail has been found at 14 sites from about one-fourth acre to 10 acres in size. Seven of those sites were destroyed in the 1994 Tyee Fire. As of January 1999, no living specimens have yet been found at those burned sites since that fire. The remaining 7 sites occur in 3 areas not burned in recent years. Five of these sites are from one-quarter to about three acres in size and occur within a quarter section of unburned Douglas-fir forest in Crum Canyon. One site has been found in Swakane Canyon, another forested drainage about 10.5 miles southwest of the first, and the original site (impacted by road reconstruction and condition not currently known) is approximately 20 miles to the north along the county road above Lake Chelan in the Twentyfive mile Creek area.

Of the above sites, two living populations of the Chelan Mountainsnail are currently known in Crum and Swakane Canyons, with a possible third at the original Lake Chelan site. The natural environment appears similar along the Columbia River south and westward to the Wenatchee River and for some distance northward into Okanogan County but, at this time, this species has not been found outside of the Entiat and Chelan Ranger Districts.

The exact location from which Smith (1937) found *Oreohelix*, presumed to be *Oreohelix* n. sp. 1, is not known except to be "Farther up the river, on the steep slope bordering Lake Chelan" (Frest and Johannes 1995). Branson (1980) reported 8 "*Oreohelix strigosa*" (more likely to be the Chelan Mountainsnail) at Lake Chelan State Park. Terrence Frest (Personal communication) recognized *Oreohelix* n. sp. 1 as an undescribed species when he found it in the Twentyfive Mile Creek area above the southwest shore of Lake Chelan. Shells confirmed as this snail by Frest (personal communication, 8/16/95) were found in 7 more locations by personnel of the Entiat Ranger District following the 1994 Tyee Wildfire. One shell from a nearby site on the Chelan Ranger District is similar to this species but diverges enough to make its identification questionable. The two living populations in Crum and Swakane Canyons were found in the fall of 1997 and summer of 1998.

D. Habitat Characteristics and Species Abundance

1. Habitat

The Chelan Mountainsnail has been found associated with two sets of environmental conditions as discussed below. Their foods and ranges of environmental tolerances are not known.

Frest and Johannes (1995) reported:

> "This species is found associated with large-scale E-facing schist talus in Douglas-fir forest at a moderate elevation. Bryophytes, liverworts, and *Seligeria*, as well as *Physocarpos*, *Sorbus*, grasses, and *Heuchera* are frequent on the talus. Surrounding forest consists of mature to young *Pseudotsuga menziesii*, as well as a significant deciduous shrub and forb component. Associated large land snails include *Monadenia fidelis fidelis*."

Elevation at the Twentyfive Mile site is 378 meters (1240 feet) (Known Site Database).

During 1995, biological surveys were done for fire recovery environmental assessments within the 1994 Tyee Fire area. During these surveys, shells resembling the Chelan Mountainsnail were found at eight locations. The shells from seven of those sites were confirmed to be of this species by Terrence Frest (personal communication, August 16, 1995). The one shell available from the eighth site diverged enough that Dr. Frest believed that additional specimens would be required to determine the species. Three of the sites were relocated and examined for habitat characteristics. These sites were in a forest edge (arid transition) situation. The Plant associations most closely resembled Ponderosa pine/Pinegrass-Bluebunch Wheatgrass, Douglas-fir/Bearberry-Bitterbrush, and Douglas-fir/Pinegrass-Elk Sedge (see Appendix A for list of species names). The sites were on the upper convex slopes near the tops of small ridges, generally at 610 to 790 meters (2000 to 2600 feet) with a mean of 700 meters (2300 feet) elevation. The microsites were often in a depression, such as a small draw or bench. Aspect was variable. Accumulations of shells were generally found in or near patches of pinegrass. *Monadenia fidelis* was not nor would it be expected to be found on these sites that are dryer and less vegetated than its normal habitat. *Oreohelix junii* and other *Oreohelix* and *Cryptomastix* have been found among talus on some of the lower slopes and in canyons in the vicinity, and the western glass-snail, *Vitrina pellucida*, occurs among deciduous leaves under shrubs on nearby slopes. But no other gastropods were found directly associated with the same habitat as this new species of *Oreohelix* in these non-talus sites.

A living population of the Chelan Mountainsnail was discovered in the fall of 1997 in Crum Canyon where five sites have now been found. These occupied sites are in a Douglas-fir/pinegrass plant association with ponderosa pine and Douglas-fir overstory, and pinegrass and/or elk sedge understory. The overstory is generally recognizable in that it is of larger more well spaced trees in a slightly better growing site than the surrounding forest (or a site that was not destroyed by the last major wildfire). Thus the more open canopy allows for a more lush grass understory. These sites are usually in a 1st order draw, or other depression in the landscape where vegetation is greener and more lush, indicating a slightly greater moisture accumulation. The snails were most often found between the litter and duff layers under healthy patches of pinegrass or elk sedge. They are also often under or near a service berry shrub. Shells were also found within a bitterbrush/bluebunch wheatgrass stand within 150 feet of the forest edge, generally under the shrubs.

In summary, habitat for this species appears to be in arid transition forests (i.e., Ponderosa pine/Pinegrass-Bluebunch Wheatgrass, Douglas-fir/Bearberry-Bitterbrush, and Douglas-fir/Pinegrass-Elk Sedge plant associations) and sometimes a short distance into adjacent shrub/steppe communities. They are usually in the more mature stands with relatively dense low vegetation understory (i.e., pinegrass, elk sedge), a good layer of litter and duff, and scattered shrubs (e.g., service berry), or in talus. They may be found between the litter and duff layers, under small or large woody debris or on or between rocks imbedded in the ground. It is unknown where they estivate or hibernate and where the young are deposited, but uncompacted soils on the sites are assumed to be important for these purposes.

Limestone, which is generally recognized as important to oreohelices, has not been identified as a significant component of this species' habitat. However, this habitat occurs in timber/grassland transition where grassland soils would be expected to be more basic than those in more dense forests. Also, light lime deposits can be found on some of the rock outcrops in the area and, since the shells of this species are highly calcareous like others of the genus, this requirement may be provided in the soil, as suggested by Henderson and Daniels (1916).

2. Species Abundance

Known surviving populations of the Chelan Mountainsnail are rare, occurring in only two or three relatively small areas within the restricted range of the species.

Oreohelix n. sp. 1 is a newly recognized, local endemic that has been found, living or dead, in about 10 locations (14 sites) from within an area of about 70,000 hectares (270 square miles, or 174,000 acres) in eastern Chelan County, Washington. Only a few living individuals of this species have been found in recent years from 3 areas. Two of the areas contain only one known site while the most populous area contains five small occupied sites in a quarter section of forested area. The other seven sites are known only from empty shells. All of the sites are scattered and range from less than one acre to a few acres in size. The original site reported by Frest and Johannes (1993), ". . . has been reduced by talus removal and road building" (Frest and Johannes 1995). Seven known sites were burned in the 1994 Tyee Fire, and survival of this snail has not yet been determined within those areas. The two newly discovered living populations are in green forested areas that were skipped over by wildfires in recent years.

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II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage

At the time of the analysis for the Northwest Forest Plan, this species was known from only one site. Since that time, two living populations have been found, and empty shells have been found at seven additional sites, all of which were burned in the Tyee Fire of 1994. To date, no surviving Mountainsnails have been found at the burned sites, and security of the original site, impacted by county road construction and maintenance, is uncertain. The two newly discovered, living populations are in green forest that is in the planning stages for management.

The knowledge gained on this species since the Northwest Forest Plan analysis increases the number of known sites occupied before the Tyee Fire to fourteen. However, these sites are scattered, linkages between them are still unknown, and living populations occur on no more than three areas, one of which contains five of the known sites within one-quarter section.

B. Major Habitat and Viability Considerations

The Chelan Mountainsnail occurs in an area that burned naturally at relatively short intervals. Prior to fire protection, these forests were under a low intensity fire regime, burning often enough to keep fuel accumulations low so fires were generally not severe, but fire protection over most of the past century has allowed fuels to accumulate so that wildfires in the area may be large, intense, and devastating to certain sensitive organisms. The Wenatchee National Forest is attempting to return these ecosystems to a natural, low intensity fire regime, but prescribed fire in these areas of accumulated fuels, are likely to burn much hotter than historically. Another concern is for the season at which prescribed fire would be used to manage these forests. During spring and fall, when prescribed burning would be implemented, is when these snails would be on the surface. During the dry summer seasons, when natural burns most frequently occurred, the snails were likely in estivation, possibly underground. Nothing is currently known of the estivation or hibernation habits of these snails, nor of the habitat used during those periods. Until more is learned about these subjects, occupied habitat areas for these snails should be protected against burning and other activities that disturb the litter, duff, or shading of the habitat. However, to protect these habitat areas from intense burns, the adjacent areas should be managed to reduce the likelihood of stand replacing wildfires.

Populations of the Chelan Mountainsnail are small and scattered. The only known means of dispersal for this species is slow (at a snail's pace), and may be hindered by natural and created barriers (i.e., streams, roads, unsuitable habitat). Dry powdery texture of the substrate resulting from effects of fire may reduce mobility of these snails for several years.

If self-fertilization occurs in this species, it would provide a means for perpetuating the species in small, low density populations. However, self- fertilization would increase inversely to population density, increasing effects of inbreeding in small subpopulations. While inbreeding must be tolerated to an extent within self-fertilizing species, it should not be discounted as insignificant if population numbers remain low for extended periods. Therefore, it is important not to further decrease populations or fragment these small habitat areas.

C. Threats to the Species

Because the Chelan Mountainsnail is known from few sites within a limited area, the range of environmental conditions it can tolerate must be considered to be narrow. Intense wildfire may be the greatest threat to their populations and habitats. Although these snails have evolved in a low intensity fire regime, high intensity fires may reduce their food below that needed for survival and/or cause changes in soil texture and moisture that cannot be tolerated. Even low intensity burns that occur during spring or fall, when these snails are on the surface or in the litter, can be detrimental by directly killing small populations, or significant proportions of them.

Other deleterious alterations to its habitat can result from forest and range management and recreation activities. Frest and Johannes (1995) indicate, talus removal, road construction and maintenance, logging, grazing, and wildfires to be threats. Threats to the species and its habitat also include: activities that compact or otherwise disturb the soil, or alter temperature or moisture regimes of the habitat (e.g., reduce shading, create or improve site drainage), or which create barriers to dispersal within populations or between nearby populations. Off-road vehicle activities would have a strong potential to threaten habitat or populations of this species, since the open grassy understory habitats are tempting playgrounds for trail bikes and 4-wheel drive vehicles. Moderate grazing is probably not a threat, but concentrations of livestock use on the occupied habitat sites would likely compact the soils, displace litter and duff, and remove vegetation needed to provide the litter for the following years' habitat. Because the occupied sites are so small, this may threaten the population and, because so few known populations survive, that could threaten species viability.

D. Distribution Relative to Land Allocations

All sites reported are on National Forest lands. The sites on the Entiat Ranger District are managed under Matrix/EW1 (mule deer winter range) and Matrix/GF (general forest resource extraction). Half of the known sites are also in the Entiat River Key Watershed. The area on the Chelan Ranger District is along a county road and is impacted by road maintenance activities.

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III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The management goal for the Chelan Mountainsnail (*Oreohelix* n. sp. 1) is to assist in maintaining species viability.

B. Specific Objectives

Short-term objectives for maintaining populations and habitat for the Chelan Mountainsnail are to protect them from fire and other deleterious effects. In occupied habitat areas, retain all components of the habitat. Specifically:

- Maintain live, green pinegrass and/or elk sedge cover as continuous as possible over the occupied habitat and through the summer, and maintain scattered shrubs.
- Maintain soil moisture and temperature, and site humidity in occupied habitats.
- Maintain relatively deep, contiguous layers of litter and duff.
- Maintain uncompacted, well aerated soil.
- Retain rocks and small and large woody debris.
- Maintain habitat contiguity where possible.

Long-term objectives could be set to restore suitable habitat for the Chelan Mountainsnail in capable sites within its range. This could be accomplished under the dry forest management strategy of the Wenatchee National Forest with interim protection of occupied habitats, as discussed throughout this document. To maintain the species across its existing range, actions that would degrade its occupied habitat, or adversely impact viability of existing populations would need to be identified and avoided until populations of the snail show recovery. Specific habitat characteristics would need to be documented before the exact desired condition for it (i.e., amount of overstory for shading on specific topographic situations, ground cover, etc.) could be described, but logic implies that these conditions would resemble the natural forests for the sites.

IV. HABITAT MANAGEMENT

A. Lessons from History

Sites on which *Oreohelix* n. sp. 1 have been found have been affected by natural disturbances and management activities. The greatest impact has been from wildfire. Construction and maintenance of the County Road along Lake Chelan has impacted that population segment to an undetermined degree. Effects of timber harvest on the species have not been observed because the snails were not recognized in the area until after the Tyee Fire. However, none of the known sites were in clear cut units harvested before the fire.

No living specimens have been found, to date, in the sites burned in the Tyee fire. Shells found after the fire are weathered, but few show scorching from the burn, although most were found in severely burned areas. It appears that they may have come out of estivation after the burn and died because their habitat no longer provided food, adequate moisture, or other habitat requirements.

B. Identification of Habitat Areas for Management

Identify the "Habitat Area" as the area around the known site locations including all of the habitat features that contribute to the environmental conditions important to the species at the known site. In most cases this could be achieved by tens of acres.

The most important sites for immediate management for the Chelan Mountainsnail are those areas in the remaining green forests, unburned by recent fires. Sites that were burned in recent wildfires should be managed to restore them to natural dry forest landscapes and monitored over time to determine long-term effects of fire and recovery potential as habitat is restored. The originally discovered site near Lake Chelan should be resurveyed to determine if the population remains, and managed appropriately to restore or maintain the habitat.

C. Management Within Habitat Areas

In reading this section, it is important to keep in mind the distinction between sites, occupied habitats, and Habitat Areas:

- **Site** -- The "site" has been defined as that point at which the species was found. The site may be an area if several specimens were found in close proximity in similar habitat.
- **Occupied Habitat** -- For this discussion, the "occupied habitat" is an area of closely similar habitat surrounding the sites, which is known or presumed to be occupied by the species. For the Chelan Mountainsnail the occupied habitats range from about one-fourth acre to ten acres or more, with currently known areas being on the smaller end of this range.
- **Habitat Area** -- The "Habitat Area", described in section B above, is the area to be managed for the species. These areas include the known sites and occupied habitats and, where needed, enough additional area to ensure that the conditions within those areas are not adversely impacted by management activities. For this species, the Habitat Areas, outside of the occupied habitats, may be managed in a manner that will restore natural dry forest conditions, while protecting the habitat components.

1. Protect Chelan Mountainsnail populations as follows:

    - Avoid burning occupied habitats to avoid directly killing the snails, and also to avoid indirectly impacting the snails by temporary food and cover loss that may also be lethal to them;

- Ensure that management activities, such as herbicide applications, are done during a season when the snails are not on the surface;
- Maintain contiguity within occupied habitats where it exists; avoid fragmenting existing habitat or creating barriers to dispersal (i.e., roads, skid trails, landings, salt licks, water troughs in or through Habitat Areas).

2. Protect or manage suitable habitat as follows:

- Maintain native grass and sedge cover as continuous as possible, using the natural site conditions as a guide, and maintain scattered shrubs.
- Maintain overstory cover to provide sufficient shade to the grassy areas to maintain proper ground-level temperature and humidity for this species during the summer, and to slow drying of the graminoids. For this purpose, all overstory should be retained on the occupied habitats until data is sufficient to determine the percent needed (i.e., the average occurring on occupied sites, stratified by aspect, slope, and ground cover).
- Maintain the natural soil temperature and moisture regime of the Habitat Area. Avoid activities that might significantly diminish shading or increase or decrease drainage.
- Within Habitat Areas, avoid such activities as prescribed fire, heavy grazing, salt licks, watering developments, off road vehicle or heavy equipment use, developed or dispersed camp sites, which may compact the soils or disturb the ground cover.
- Conserve the natural biotic community over time (e.g., manage under a dry forest management strategy, while maintaining or protecting the currently occupied habitats for this snail).
- Retain rocks on and imbedded in the ground. Avoid disturbing talus in which these snails occur; avoid removing downslope materials that may destabilize talus or alter environments within it.
- Maintain a component of large and small woody debris on the Habitat Areas, but manage at low fuel loads using hand removal of excessive fuels within occupied habitats.
- Manage adjacent stands to maintain low fuel loads for protection against intense wildfire using appropriate means (thinning where needed, hand and mechanical treatments, prescribed burning), but protect occupied habitats from burning during treatment of surrounding areas.
- Manage Habitat Areas in stands as large as possible to avoid fragmenting habitats or populations.

D. Other Management Issues and Considerations

Livestock grazing could have adverse impacts on habitats by removing too much of the grass cover that provides the litter and duff used by these snails, by disturbance of the ground cover, or by compacting the soils.

Off road vehicle use (i.e., four-wheel drive and trail bikes) should be prohibited in or near occupied Chelan Mountainsnail habitats.

Noxious weeds should be controlled to ensure against habitat degradation caused by displacement of the native plant cover used by the Chelan Mountainsnail. If herbicides are to be used, application in occupied sites should be done at a time when the snails are not on the surface. That is, the vegetation should not be wet, and litter should be dry down into and including the upper surface the duff layer.

Recovery of this species could be projected through long-term management of the forests in which it occurs by dry, open-forest, timber management practices that protect occupied sites from excessive ground disturbance and direct burning. Restore habitats within the forest until this snail becomes well distributed within its range. Precommercial thinning, if done in a manner that avoids compacting the soils and/or disturbing ground cover, may improve the habitat for these snails by allowing greater density of ground vegetation to build the litter and duff layers. Most thinning slash should be removed from occupied habitats for disposal by means that would minimize site disturbance. Commercial thinning may also be acceptable, but would need to be planned on a site specific basis after more is learned of the shade requirements for maintaining microsite characteristics of the habitat.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

1. Range and distribution of *Oreohelix* n. sp. 1 are incompletely known.

2. The following habitat relationships need to be investigated:

   a. **Schist Talus**: Talus provides suitable microsite conditions and food to support the species. Temperature is noticeably lower and humidity noticeably higher under talus than in the surrounding environment. While the food habitats of this species are not known, talus contains a variety of vegetation, subterranean roots, fungi, and organic debris that becomes trapped among the rocks. A variety of bacteria and invertebrates are also available among the vegetation and debris.

   b. **Open Douglas-fir and Ponderosa Pine Forest:** Is some shading required to maintain site temperature or humidity? Is there an interdependence between

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Oreohelix n. sp. 1 and certain plants or other organisms (e.g., pinegrass) within these communities?

c. **Slight depressions and shallow draws:** Are these microsites important to the species for essential moisture levels. Can a critical threshold be quantified?

d. **No apparent cover on the rockless sites:** Snails may burrow into soil for cover. Is soil type or geology a factor of this?

e. **Coarse or sandy soils and rock type:** What is the importance of soil type and geology to this species?

f. **Pinegrass and elk sedge present:** How important is this observed association to the Chelan Mountainsnail? Are these graminoids important in the ecology of the snails for food, cover, etc.; do the rhizomes maintain proper soil structure; do they occur on the same sites because of the proper moisture and other habitat associations, or all of the above plus?

B. Research Questions

1. What is the actual range of the Chelan Mountainsnail? Where do other populations of it occur? How extensive are habitat areas?

2. What amount of connectivity or interaction occurs between occupied habitats or populations? What conditions present barriers to interactions within or between populations?

3. What are essential habitat components for this species [soil type, pH, temperature, moisture regime, ground cover (i.e., rock, woody debris, litter), canopy cover, specific plants]?

4. What are the foods of this species?

5. Where are the young deposited; do they require different conditions than the adults?

6. What are the effects of specific herbicides on these snails? How can adverse effects be reduced or avoided?

7. Since the Chelan Mountainsnail is an undescribed species, would a DNA study assist in clarifying species of *Oreohelix* within the range?

C. Monitoring Needs and Recommendations

A concern for the management of little known species, such as the Chelan Mountainsnail, is the lack of knowledge of specific habitat conditions, and the effects of management for one species on other equally important species within the biotic community. While an ecosystem management approach is the most reasonable, habitats or niches of representative species need to be understood, so that important components are not inadvertently discarded. Effectiveness of management prescriptions need to be monitored following activities.

1. Monitoring is needed on the sites burned in the Tyee fire for understanding of long-term effects of fire on this species (i.e., does the species still survive in those areas; will the populations recover?).

2. The Twentyfive Mile Creek site on Chelan Ranger District should be monitored to determine whether or not it is still intact and supporting the snails, following county road reconstruction and maintenance during 1995.

3. Activities prescribed in habitat areas should be monitored for implementation and effectiveness in achieving the desired results.

4. Monitor livestock grazing on and near occupied habitats to ensure against habitat degradation from soil compaction, excessive vegetation removal, or ground cover disturbance.

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APPENDIX A - Common and Scientific Names of Species

PLANTS

Alumroot	Heuchera
Bearberry	Arctosaphylos uva ursi
Bitterbrush	Purshia tridentata
Bluebunch Wheatgrass	Agropyron spicatum
Douglas-fir	Pseudotsuga menziesii
Elk Sedge	Carex geyeri
Pinegrass	Calamagrostis rubecens
Mountain Ash	Sorbus
Ninebark	Physocarpus malvaceus
Ponderosa Pine	Pinus ponderosa
Seligeria	small mosses which grow on rocks

SNAILS

Cryptomastix	Oregonian (species unknown)
Monadenia fidelis	Pacific Sideband
Oreohelix junii	Grand Coulee Mountainsnail
Oreohelix n.sp.1	Chelan Mountainsnail
Oreohelix n.sp.2	Yakima Mountainsnail
Oreohelix variabilis	Mountainsnail (no common name)

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SECTION NO. 13
Pristiloma Arcticum Crateris
Crater Lake Tightcoil

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Management Recommendations for *Pristiloma Arcticum Crateris*, Crater Lake Tightcoil

V. 2.0

by

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Challis National Forest

and

Thomas E. Burke
Entiat Ranger District
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EXECUTIVE SUMMARY

Species: *Pristiloma arcticum crateris* Pilsbry, 1946.
Common Name: Crater Lake Tightcoil

Taxonomic Group: Mollusks -- land snail.

ROD Components: Survey Strategies 1 & 2, and Protect From Grazing.

Other Management Status:
- Oregon Natural Heritage Program, list 1--species critically imperiled because of extreme rarity or because they are especially vulnerable to extinction or extirpation, (typically with 5 or fewer known occurrences); and
- Bureau of Land Management, Bureau Sensitive in Oregon.

Range: *Pristiloma arcticum crateris* may be found sparsely distributed throughout the Oregon Cascades, at moderate to high elevations, roughly 600 to 2000 meters (2000 to 7000 feet). It has been found from south of Crater Lake in southern Oregon to the Bull Run Watershed in northern Oregon. They are currently known from about 8 sites within 3 localities in this range, 6 of those sites being in the Crater Lake locality.

Specific Habitat: This species may be found on logs and other woody debris, or among litter in moist to wet forests, or in well vegetated meadows in forested settings. Expected microhabitats include moist to wet sites such as riparian areas, and near springs, seeps, wetlands, and mountain meadows. Essential habitat components include uncompacted soil, litter, logs, and other woody debris in a site where the ground is shaded or otherwise protected from excessive fluctuations in temperature and humidity. Ranges of microclimate tolerances are not known.

Threats: Loss or degradation of the habitat at the few sites from which the Crater Lake Tightcoil is known might threaten the species. Activities that compact soils or snow, disturb ground vegetation and/or litter, remove woody debris, alter temperature and/or humidity of the microsite, or alter the water table would be deleterious to the habitat of this species. These activities include livestock grazing, timber management, recreation (i.e., camping, ORVs), burning, heavy equipment operation, and construction activities. With so few known locations, inadvertent degradation of occupied sites, not yet known, would also be of concern.

Cold temperatures and short growing seasons at the higher elevation habitats where some of these populations are located would limit activity to just a few of the warmer months of the year (Pilsbry 1946). This species almost certainly has a 1-year life span and produces only one clutch of eggs (Frest and Johannes 1995). Therefore, the loss of a single cohort could have devastating consequences on the population.

Management Recommendations: For populations on National Forest and BLM administered lands, during grazing, timber management, recreation, and other land management activities:

- Maintain shading to minimize temperature and humidity fluctuations on and within the ground at the site.
- Maintain natural understory vegetation and a layer of uncompacted organic litter and debris on the ground.
- Avoid activities that would cause soil compaction. Litter and porous soil will provide cover and insulation against temperature extremes.
- Maintain existing logs and other woody debris. Close Habitat Areas to firewood gathering.
- Avoid activities that would lower the water table at the site, thus reducing soil moisture below that required by the species, or possibly altering vegetative communities.
- Avoid burning within occupied habitats.
- Protect from grazing.

Information Needs: Specific areas in which there is a lack of or insufficient data include:
- Accurate range of the Species and extent of populations;
- Specific habitat conditions required (i.e., temperature and moisture tolerances, and how these are maintained within the natural habitat);
- Biology (breeding season, egg repositories, life span, seasonal habits, i.e., aestivation, hibernation);
- Ecology (food, ecosystem functions);
- Predators, diseases, and other natural threats;
- Additional refinement of search methodology may be needed because of the minute size of this species.

Monitoring Needs & Recommendations: Studies or monitoring of *Pristiloma arcticum crateris* should use sampling methods that effect less than 5% of the suspected habitat area or population.

1. Verify existing known populations:
   - describe macro and micro-habitat conditions; and
   - determine the extent of the populations.
2. Conduct surveys to locate additional populations in areas identified as potential habitat. Consider adding this species to management strategy 3 or 4 to collect this information.
3. Monitor known population sites following land management activities for effectiveness of management recommendations applied.

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Pristiloma arcticum crateris was originally described by Pilsbry (1946) when it was known from a single locality one mile south of Crater Lake. Henderson (1929) had reported it as *"Anceyia* species undetermined."

Pilsbry (1946) gave no reason for considering this to be a subspecies of *P. arcticum*. Frest and Johannes (1995(b)) agreed with Riedel (1980) that *P. a. crateris* may be a distinct species. Since, to date, no one has published findings from dissection or genetic analysis of the relationships of these snails, Pilsbry's classification is accepted.

B. Species Description

1. Morphology

This is a minute snail, about 2.75 mm diameter in 5 1/8 whorls. The shell is imperforate with a low conic spire, and it is tightly coiled with a crescentic aperture. There are no apparent sulci (radial indented lines on the shell). It is distinguished from other similar *Pristiloma* by its unshouldered last whorl, the periphery of which is rounded and widest at about mid-whorl. The basal apertural margin is a little more flattened than that of *P. arcticum arcticum*.

Pilsbry (1946) described this species as follows: “The shell is imperforate, depressed, with quite low, conoid spire and rounded periphery, median in position; pinkish buff, glossy. Sculpture of weak but subregular ripples of growth below the suture, soon disappearing, leaving the peripheral region and base smooth except for very weak lines of growth; very fine, close spirals are seen on the upper surface. The whorls are regularly and rather closely coiled, the last not unduly wider. The aperture is narrowly crescentic, the outer and basal margins of the lip thin, columellar margin slightly spreading, thickened within, reflected at the insertion in a small callus over the axis. Height 1.5 mm, diameter 2.75 mm; 5 1/8 whorls.

“The shell is smaller than that of *Pristiloma idahoense* (Pilsbry 1902) with the peripheral convexity median, not above the middle as in *P. idahoense*. *P. a. crateris* is very similar to *P. a. arcticum*, but the base is more flattened, producing a less deeply concave basal lip and somewhat different shape of aperture, and there is a fraction of a whorl more (Pilsbry, 1946).”

2. Reproductive Biology

Specific reproductive biology of *P. arcticum crateris* is unknown at present. However, Frest and Johannes (1995) wrote that almost all small land snails are hermaphroditic and semelparous (i.e., breed only once in a lifetime). Most small land snails live only one year unless conditions prohibit breeding, in which case some may over-winter so they may breed the following year.

3. Ecology

No information specific to the ecology of *P. a. crateris* was available as of December 1998. However, the species is one of many organisms that compose the biotic community within the ecosystems in which they occur. Each species occupies a specific niche, and performs its functions that, working together with all other organisms in the community, maintain a balance within that segment of the ecosystem. Minute snails are often numerous where they occur, and probably contribute significantly as primary and secondary consumers. As consumers, they contribute to soil building and probably also contribute to the dissemination of spores and possibly other microbes. Most gastropods are alternate hosts for one or more parasites within natural ecosystems.

C. Range, Known Sites

Pristiloma arcticum crateris may occur locally throughout the Oregon Cascades. Although, it has been found in only 3 localities (including about 8 sites), these areas are widespread. Junius Henderson first collected this subspecies in 1928 from 1.4 km. (1 mile) south of Crater Lake, in Crater Lake National Park, Klamath County, Oregon (type locality). Collections were made at a second site by Allyn G. Smith in July 1968, and July 1970. This site is at Wizard Falls Fish Hatchery on the Metolius River, Jefferson County, Oregon. In 1997, Terrence Frest and Edward Johannes collected it from at least three sites in the Upper Klamath Lake watershed, south of Crater Lake National Park and in the Thousand Springs area, west of that Park (T. Frest, personal communication). In the spring (1998), immature specimens were found in the riparian zone of the Bull Run River, Multnomah County, Oregon (Burke, field notes and collection).

D. Habitat Characteristics and Species Abundance

1. Habitat Characteristics

The type specimens of *P. arcticum crateris* were reportedly found "on pine logs" (Known Site Database). Those from the Bull Run Watershed were under bits of conifer bark under a small shrub in a moist forested riparian site. Although typical *P. a. arcticum* is generally considered to be from high elevations (near or above timberline), the sites from which *P. a. crateris* are known are from 838 to 1950 meters (2750 to 6400 feet) elevation. *P. a. arcticum* is usually found in bogs or other acid habitats, while *P. a. crateris* is more often found in non-acid fens or sedge habitats (T. Frest, personal communication). Frest emphasized that the sites where he has found *P. a. crateris* are small openings such as "spring meadows" in generally undisturbed forests. They may be found on or under woody debris or on the bases of sedges. If the site has been grazed, these snails are usually lacking, but they may occur in spots missed by the livestock (T. Frest, personal communication).

Microsite conditions for these snails can be discussed based on their basic environmental needs for relatively even, cool temperatures and humidity, an available food source, and cover for protection from enemies and the elements. Natural porous soils and litter provide some cover necessary for protection against excessive temperature and humidity fluctuations, as well as for hiding or escape from predators. While the microclimate ranges tolerated by this species are not known, it is unarguable that, without suitable habitat, those ranges would be exceeded. Where and how these snails or their eggs overwinter, is also important. Since the specific details of this are not currently known, maintaining existing habitat is essential for not disrupting the reproductive cycles of this species.

Foods of this species are also unknown, but living on woody debris or among decaying litter implies that they likely feed upon fungi or other organisms that break down those organic materials. Green understory vegetation is important in maintaining temperature and humidity at ground level. The roots help to maintain soil texture and porosity, and the plants contribute to liter and humus, and provide organic matter that produces the microphytes on which these snails and other invertebrates feed. Shading and evapotranspiration help to maintain the humidity and cool temperature in the forest floor litter and debris, which in turn provides the microhabitats depended upon by the snails, and probably their food sources as well. Overstory vegetation that shades the ground is also important because it moderates temperature and moisture fluctuations by its influence on the overall habitat.

2. Species Abundance

At present, very few *Pristiloma arcticum crateris* have been found. The Known Site Database indicates that two specimens were found in the Henderson collection in the Academy of Natural Sciences of Philadelphia, collected from the type locality in 1928, and the Smith

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collection at the California Academy of Sciences contains two records, collected from the Metolius River site two years apart, 1968 and 1970. Four specimens (1 sub-adult; 3 small juveniles) were found under the same piece of bark at the Bull Run Site. Pilsbry (1946) suggested that there might be other specimens of Henderson's, from the type locality, in the collection at the University of Colorado.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage Standard and Guideline

The very few, isolated, known populations make the Crater Lake Tightcoil a species of concern.

This species was listed under both the "Protect Sites From Grazing" Standard and Guideline; and Table C-3, Survey Strategies 1 and 2 (USDA, Forest Service, and USDI, Bureau of Land Management, 1974: Standards and Guidelines C-6 and C-59). The analysis for *P. arcticum crateris* projected a 40% likelihood that it would be well distributed, 37% that it would be locally restricted, 17% that it would be restricted to refugia, and 7% that it would be extirpated, under Option 9 (the preferred alternative) of the FSEIS (USDA, Forest Service, and USDI, Bureau of Land Management (1974: Appendix A, IV-128). According to USDA, Forest Service, and USDI, Bureau of Land Management (1974: J2-333), the rating reflects the potential for the species to be disturbed by grazing, and uncertainty about what level of protection is afforded by the alternative (Option 9).

The above analysis was done based on the type locality as the only known site, with no information on habitat or ecology of the species. Since that analysis, a little more information on range and habitat has become available, with the discovery of two additional localities in which the species is present. This addition to the known range of the species improves the probability of survival of known populations, but three localities are still not enough to ensure species viability, especially when each of the two of these localities still have only one known site of occurrence.

B. Major Habitat and Viability Considerations

Present knowledge of the Crater Lake tightcoil indicates that it may be one of the least stable of the land snails on Table C-3. With only three localities in which *P. a. crateris* is known to occur, extirpation of one or more of the existing known populations could be foreseeable through natural catastrophic events or inadvertent human caused degradation of habitat. At present it is not known whether this species is widespread but overlooked within its range, or if it is highly locally endemic. Other populations are likely to occur but are currently unknown, thus any reliance on additional sites for maintaining the

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species would be speculative. Without coverage under the survey and manage standards and guidelines, strategy 2, other populations could be inadvertently destroyed without knowing that they had existed. With each one lost, the limited number of populations would move the species nearer to extinction, intensifying the importance of the remaining ones.

As well as being more easily lost than larger, well distributed populations, small populations and low population densities tend to reduce the number of unrelated individuals available for mating, thus increasing the chance of inbreeding within the population. Inbreeding generally tends to reduce the genetic diversity, which usually reduces adaptability, and weakens a population's chance of survival in a variety of ways.

Currently, too little is known of the habitat and ecology of the Crater Lake tightcoil to propose management other than protection of sites that are known to be supporting populations. As Pilsbry (1946) suggested for *P. a. arcticum*, habitats in the higher elevations of its range offer cold temperatures and short growing seasons, which would limit activity of these snails to a relatively short annual period for growth and reproduction. Frest and Johannes (1995) related that small species, like this one, almost certainly have a one-year life span and lay only one clutch of eggs. Therefore, the loss of a single cohort could have devastating consequences for the population.

C. Threats to the Species

Activities that compact soils, reduce litter and/or vegetative cover, or impact potential food sources (i.e., livestock grazing, heavy equipment use, ORVs, and camping on occupied habitats) would be deleterious to the survival and productivity of this and similar species. Natural porous soils and litter provide cover necessary for protection against temperature and humidity extremes, as well as for hiding or escape from predators. While the microclimate ranges tolerated by this species are not known, it is apparent that without suitable habitat, those ranges would be exceeded.

Depending on specific site characteristics, removal of ground shading overstory would also impact this species by allowing excessive fluctuations in ground temperature and humidity. These effects may be less extreme at higher elevations and on wetter sites, but no studies have been done to evaluate such a theory, or to determine under what conditions the overstory might be less important.

These snails appear to occur on wetter sites than in general forest conditions, so activities that would lower the water table or reduce soil moisture would degrade the habitat.

Intense fire that burns through the litter and duff layers is devastating to most gastropods, and even light burns during seasons when these animals are active can be expected to have more serious impacts than burns during their dormant periods. Effects of fire retardant chemicals on small snails are not known and may be deleterious.

Removal of logs and woody debris from occupied habitats for firewood gathering for campfires, or by a burn would degrade the habitat.

Snowmobiling or skiing would impact these snails if snow, over their occupied habitats, is compacted losing its insulative properties and allowing the litter or ground to freeze.

D. Distribution Relative to Land Allocations

Of the known sites, one is in Crater Lake National Park, one is in LSR, Tier 1 Key Watershed on the Deschutes National Forest, and one is in the closed area of the Bull Run Watershed, LSR, Tier 2 Key Watershed on the Mount Hood National Forest. The recent sites discovered by Frest and Johannes are on the Winema and Rogue River National Forests (land allocation will be determined when the exact site locations are received).

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The goal for management of *Pristiloma arcticum crateris* is to assist in maintaining viability of the species.

B. Specific Objectives

Identify and maintain the habitat for *Pristiloma arcticum crateris* at known sites and in other areas in which it occurs on National Forest and BLM administered lands. Site conditions and responses to disturbance will vary with the physical and biological characteristics of the site. Therefore, each site would need to be evaluated to determine such characteristics as: Plant community, elevation, moisture regime, degree of shading, etc., and how these relate to the microhabitat of the species. In addition the sites protected or managed for this species will need to be large enough to ensure that conditions of the habitat are not degraded by activities adjacent to the habitat. Specific objectives include:

1. Protect occupied habitats against activities that might injure more than a few individuals within a population.

2. Protect occupied habitats against natural and/or human-caused degradation. Maintain:

- natural temperature and humidity regimes;
- soil moisture (water table) of the sites;
- natural soil texture (avoid compacting soils);
- a large woody debris component within the habitat areas;
- natural ground cover of low vegetation, litter and duff.

IV. HABITAT MANAGEMENT

A. Lessons from History

The Crater Lake Tightcoil is not found in heavily grazed areas (T. Frest, personal communication).

B. Identification of Habitat Areas for Management

All known and newly discovered occupied sites should be managed for this species. Identify the "Habitat Area" as the area around the known site locations including all of the habitat features that contribute to the environmental conditions important to the species at the known site. In most cases this might be achieved by tens of acres (USDA, Forest Service, and USDI, Bureau of Land Management, 1974: ROD C-5). However, the extent of the population would need to be determined and the Habitat Area delineated based on that and enough additional area to maintain the microhabitat characteristics within the occupied area. Consideration should be given to daily and yearly activity cycles of the snails as this data is collected.

Three localities, including about 8 sites, are currently known to be occupied by the Crater Lake Tightcoil as of December 1998. Most, if not all, of these populations are on Federally managed lands that are under management allocations that afford some, but not complete protection. Until additional populations are discovered and the extent of the populations and habitat can be adequately assessed, all populations are considered important to maintain the species.

C. Management Within Habitat Areas

In reading this section, it is important to keep in mind the distinction between sites, occupied habitats, and Habitat Areas:

- **Site** -- The "site" has been defined as that point where the species was found, or a small area where more than one specimen was found within 30 feet of each other.

- **Occupied Habitat** -- For this discussion, the "occupied habitat" is an area of closely similar habitat surrounding the sites, which is known or presumed to be occupied by the species. Lack of experience with the Crater Lake Tightcoil leaves us with little understanding of how large an

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occupied habitat area might be, but we can speculate that they might range from a few acres to 50 or more.

- **Habitat Area** -- The "Habitat Area", described in section B, above, is the area to be managed for the species. These areas include the known sites and occupied habitats and, where needed, enough additional area to ensure that the conditions within those areas are not adversely impacted by management activities.

Proper overall management will be required to maintain microsite conditions for these minute snails. A large enough area would need to be provided for their habitat to maintain suitable conditions within the habitat area and avoid degradation caused by changes to adjacent areas. During grazing, timber management, and other land management activities:

1. Protect occupied habitats against heavy equipment, off road vehicles, heavy livestock use, camping, and other ground disturbing activities that might injure these snails. Site disturbance for surveys, monitoring, and other activities should be limited to less than 5% of occupied habitats.

2. Protect occupied habitats against natural and/or human-caused degradation, and
   - Maintain overstory vegetation sufficient for ground shading to minimize temperature and humidity fluctuations on and within the ground at the site. The amount and type of shading required will vary with the elevation and general climatic conditions at the sites. This will depend on the natural overstory and/or other vegetation, the water table or soil moisture content, the normal summer daytime temperatures (aspect, elevation), etc.
   - Maintain natural understory vegetation and ground cover of litter and duff.
   - Avoid activities that would cause soil compaction. Litter and porous soil will provide cover and insulation against temperature extremes.
   - Maintain existing logs and other down woody debris. Availability of logs will depend on the overall plant community at the site. At sites near or above timberline, other habitat characteristics may replace the function provided by logs at lower elevations. Within lower elevation forested habitats, large woody debris exceeding 1000 linear feet per acre is not excessive. Where overstory is sufficient, trees could be felled to increase logs on habitats where they are limited.
   - Avoid activities that would lower the water table, thus reducing soil moisture below that required by the species, or possibly altering vegetative communities.
   - Avoid burning occupied habitats; protect from wildfire.

3. To manage the Habitat Areas for this species, actions that may need to be taken include:
   - exclude livestock grazing;
   - prevent or control noxious weeds in a manner that does not expose these snails to potentially toxic chemicals;
   - keep heavy equipment out of the occupied habitat;
   - close occupied habitat to camping and ORV use;
   - manage fuels in areas adjacent to occupied habitats;
   - modify vegetation management objectives within Habitat Areas to comply with the needs of these snails;
   - close Habitat Areas to firewood gathering.

D. Other Management Issues and Considerations

Pristilomas have very thin, fragile shells, and they are easily damaged.

Known sites for *Pristiloma arcticum crateris* are mostly on Federally managed lands allocated to some type of protection. While this does not in itself ensure that these populations will be protected over time, it is a safeguard against their being impacted directly by certain management activities. They are still vulnerable to some activities, however, such as grazing, prescribed fire, and recreation activities that might establish high use (dispersed or developed) campsites on the occupied habitat of a small population, and possibly salvage or other silvicultural activities.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

Little is known for certain about *Pristiloma arcticum crateris*, and nearly any additional information would be valuable in understanding how to manage ecosystems that would support this species. Specific areas in which there is a lack of or insufficient data include:

- accurate range of the species;
- specific habitat conditions required (i.e., temperature and moisture tolerances, and how these are maintained within the natural habitat);

- biology - breeding season, egg depositories, life span, seasonal habits (e.g., aestivation, hibernation);
- ecology--food, ecosystem functions;
- predators, diseases, and other natural threats.

There may also be a need for better survey methods for this species, because its minute size makes it difficult to find.

B. Research Questions

- What is the extent of the range of *Pristiloma arcticum crateris*; where do other populations occur within that range?
- What is the extent of and the density of each population?
- What are its specific habitat requirements; if it is found in different plant communities, how do the specific conditions vary within different communities?
- How long do these animals live; how many times do they reproduce? Where are their eggs deposited?
- How do they overwinter; where do they spend the hot dry seasons?
- What do they eat; does their diet vary by season?
- What preys on these snails; are they threatened by diseases or other pathogens?

C. Monitoring Needs and Recommendations

Any studies or monitoring of populations of *Pristiloma arcticum crateris* should be by sampling methods that effect less than 5% of the suspected habitat area or population.

1. Verify existing known populations, locate their occupied habitats, and:
   - describe macro and micro-habitat conditions;
   - determine the extent of the populations.

2. Conduct surveys to locate additional populations in areas identified as potential habitat. Prioritize surveys in areas where management treatments or projects are scheduled or proposed. Consider adding this species to management strategy 3 or 4 to collect this information.

3. Monitor known populations following land management activities to determine whether or not recommendations applied for this species protection are effective and sufficient.

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SECTION NO. 14

Trilobopsis tehamana Tehama Chaparral

Trilobopsis roperi Shasta Chaparral

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Draft Management Recommendations
for
Trilobopsis tehamana, Tehama Chaparral and *Trilobopsis roperi*, and Shasta Chaparral *(Land Snails)*

Version 2.0

by

Ted R. Weasma

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EXECUTIVE SUMMARY

Species: *Trilobopsis tehamana* (Tehama chaparral) and *Trilobopsis roperi* (Shasta chaparral)

Taxonomic Group: Mollusk (Mollusca) Snail (Gastropoda) Land snail (Order Pulmonata)

ROD Components: Survey and Manage Strategy 1 & 2

Other Management Status: None identified at this time.

Range: *T. tehamana* is a local endemic from Tehama, Butte, and Siskiyou counties, California and is known from 6 sites (Appendix J-2). *T. roperi* is a local endemic known from 12 sites in Shasta County, California (Appendix J-2).

Specific Habitat: *T. tehamana* has been found in shaded talus (rock piles), rockpiles along the bank of the Shasta River, and under leaf litter and other debris on the ground in adjacent forested habitats. *T. roperi* is expected to be found in similar habitat, but appears to be more closely associated with limestone substrates.

Threats: Given that little information is available about the habitat needs of the species, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities that increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means, including fire, herbicide use, recreation development, over-collecting, and disturbance during aestivation may constitute a major threat to this species.

Road building and substantial road maintenance were identified as specific issues of concern for *T. roperi* in Appendix J-2. For *T. tehamana*, occurrence outside of Riparian Reserves in matrix lands was identified as an issue of concern.

Management Recommendations: In general, manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Adjacent forested areas should be managed to provide shade, coarse woody debris, and uncompacted forest litter. Due to the rarity of known populations, sites should be protected from wildfire events.

Mitigation measures outlined in Appendix J-2 for *T. tehamana* stress the importance of the proper implementation of Riparian Reserves under option 9. Additions to Riparian Reserves should be considered when surveys locate the species outside of standard reserve areas. For *T. roperi*, surveys prior to road building or major road maintenance are considered to be particularly important.

Information Needs: Information is needed on the actual range of these species, the location of other populations outside of the known site areas, the viability and stability of the known populations, and the factors that control viability.

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I. NATURAL HISTORY

A. Taxonomic and Nomenclatural History

Trilobopsis tehamana was first described as *Polygyra tehamana* by Pilsbry in 1928 (Proc. Acad. Nat. Sci. Phila., 80: 178, fig. 1). Based on a review and study of anatomical characterisitcs, Pilsbry established the genus *Trilobopsis in 1939* (Mollusca of North America I, pt. 1, p. xvi), and placed *P. tehamana* and *P. roperi* in *Trilobopsis* in 1940 (Land Mollusca of North America Vol. I, pt. 2, p. 787-788. fig. 471).

Trilobopsis roperi was first described in the genus *Helix by* Pilsbry (1889, Nautilus, 3:14, text figs.; 1893, Man. Conch., 8:154, p1. 50, figs. 19, 20: Nautilus. 12:59). It was moved into the genus *Polygyra by Binney in 1890 (Polygyra roperi* Pils., W. G. Binney, 1890, 3d.supl., Bull. Mus. Comp. Zool., 19: 212, text-fig.-Pilsbry, 1898, Nautilus, 12: 59.-Hanna & Nicholson, 1930, Nautilus, 44:17). Pilsbry placed the species in the genus *Trilobopsis* in 1940 (*Trilobopsis roperi* (Pilsbry) 1940 Land Mollusca of North America I, pt. 2, p. 786-787. fig. 470). See also to the references cited for *T. tehamana*.

B. Species Description

1. Common Characteristics

These 2 species are covered in the same management recommendations because they are closely related and occupy similar ranges and habitats. The 2 species can be separated by shell characteristics.

2. Morphology

Pilsbry (1939) considers the following to be key characteristics of *Trilobopsis*: "The small shell is strongly depressed with rounded periphery, usually perforate or umbilicate, the surface with interrupted thread-like or scale-like periostracal processes. Embryonic shell smooth except for some weak radiating striae below the suture. Aperture with a curved parietal tooth and two lip teeth, the peristome reflected." "The stout penis has a simple wall, no external sheath, and no verge. The epiphallus is well differentiated from the vas deferens, and without a flagellum. The spermathecal duct is of the usual short type, and may not be either swollen, as in *T. tehamana*, or not noticeably so as in *T. loricata*. The talon has a rather long stalk."

The jaw is thin, with ribs indicated by their edges, not appearing thicker than their intervals." "Teeth few, 10.6.1.6.10 in *T. tehamana*. Centrals and laterals with well developed ectocones. On the marginals the mesocone is bifid and the ectocones vary from one to three, or even

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four; on the outermost teeth cusps are obsolete as usual (Fig. 466: 6). *T. loricata* has 20.1.20 teeth, according to Binney, formed as in *T. tehamana*."

Mature specimens are over 5 mm. in diameter and under 10 mm. in diameter and have a reflected aperture lip. The body whorl is constricted behind the reflected lip. The genus is separated from Vespericola by its smaller size, a depressed-globose to nearly discoidal shape rather than a globose to depressed-helicoid shape, and other features. Trilobopsis is named for the three-lobed shape of the aperture (parietal, basal, and palatal lamellae). Vespericola do not have basal or palatal lamellae. Refer to the basic key supplied by Roth, 1996.

When comparing these species to other species within the genera, the umbilicus becomes a key feature, according to Pilsbry's key. *T. roperi*, *T. penitens*, and *T. tehamana* all have a large umbilicus that separates them from all other *Trilobopsis* species with an umbilicus that is small or closed. *T. roperi* has a surface of fine hairs, in contrast to *T. penitens* that has flattened, rather coarse scales, and *T. tehamana* has a surface with fine striae and is papillose in the umbilicus.

Burch & Pearce (1990) consider the following to be key shell characteristics separating this and similar genera from *Allogona(Sub genus Dysmedoma)*.

"Last whorl distinctly constricted behind [the] lip; shell not distinctly striate; shell less than 24 mm in width; aperture with up to three teeth; shell with or without hairs, umbilicate or imperforate"

Key features separating this genera from *Vespericola* and some *Cryptomastix*, according to Burch & Pearce, are "Shell 6-8.5 mm wide; parietal tooth always present; aperture without or up to two lip teeth"

The final key break that separates *Trilobopsis* from *Cryptmomastix* is the aperture with a curved parietal tooth and two lip teeth; shell 6.0-8.2mm wide; . . .". *Cryptomastix* has no lip teeth.

The Type is *Helix loricata* GId.

Trilobopsis tehemana

According to Pilsbry's 1940 description, "The shell is discoidal, umbilicate, the umbilicus contained about five times in the diameter; cinnamon colored (maculate with black, if the animal is dried in). Surface dull, with the apex pale, smooth, following whorls with some growth wrinkles, the base having microscopic sculpture of very close, somewhat anastomosing radial wrinkles and in places weak spiral lines, the interior of the umbilicus with much coarser papillae. The last whorl is strongly contracted behind the lip and descends abruptly to the aperture. The aperture is small, oblique, with reflected pale brown lip; three teeth, and a squarish tooth within the outer lip." "Height 3.2, diameter 7 mm.; 5 1/3 whorls." Pilsbry goes on to say "This species differs from *T. loricata* (Gld.) in sculpture, as well as by the large umbilicus, smaller aperture, more closely coiled whorls, and more discoidal shape. *T. roperi* (Pils.) has a larger aperture and different sculpture."

Soft body features are described by Pilsbry as, "The mantle is reticulate-spotted with black. Foot uniform light colored, the eye-stalks light gray."

Trilobopsis roperi

Pilsbry describes in 1940, "The shell is rather broadly umbilicate, the umbilicus contained about 4 1/2 times in the diameter, discoidal, the spire almost flat, of closely coiled whorls, periphery and base rounded; last whorl deeply contracted behind the outer and basal margins of the lip, which is buckthorn brown. Embryonic 1-1/2 whorls smooth; later whorls with sculpture of long granules in the direction of lines of growth, over a microscopic spiral striation, the granules rather ill-defined on the last whorl where, in protected places, short erect hairs in forwardly descending trends remain. The somewhat triangular aperture has the lip well reflected at outer and basal margins, and is obstructed by three teeth: parietal tooth rather high and long but not extending to the columellar end of the lip; outer tooth strong, somewhat square-topped; basal tooth strong but rounded at top." "Height 3.3 mm., diameter 8.2 mm.; 5 3/4 whorls." "Distinguished by its nearly flat spire, wide umbilicus and the sculpture of erect hairs that, however, are mostly lost from the 'dead' specimens seen."

3. Reproductive Biology

The species are hermaphroditic. No other data, other than the anatomy of the sexual organs, has been published for these species.

4. Ecology

During the summer, both species may be found under rocks or large woody debris that serve as refuge sites from desiccation. During the wet seasons, they may be found away from refugia foraging for green vegetation and fruit, feces, old leaves, leaf mold, and fungi. Mollusks that inhabit talus slopes also utilize the surrounding forest areas during moist, cool conditions, ranging out from the refugia to forage in litter of the the adjacent forest floor. Vegetation within the surrounding forest not only moderates the temperature and moisture conditions within the rock habitats, but provides food, loose soil, and litter conditions necessary for egg laying.

Generally, the lower one third of a talus slope contains the largest, most stable habitat elements. Because of the long-term stability in these areas and larger interstitial spaces between the rocks, microsite conditions are more favorable and provide dependable refugia sites. It is important, therefore, to avoid disturbance of the bottom of the slope that could result in loss of these refugia areas and destabilizion of the entire talus field.

T. tehamana has been found associated with *Monadenia chaceana*, *Vespericola Sierrana*, *Vallonia cyclophorella*, and *Pristiloma chersinella*.

C. Range, Known Sites

T. tehamana is a local endemic from Tehama, Butte, and Siskiyou counties, California and is known from 6 sites (Appendix J-2). The **Type Locality** is Battle Creek, Tehama County, California. It is also known from the Shasta River Canyon, Siskiyou County, California. Two known sites are outside the range of the Northern Spotted Owl.

T. roperi is a local endemic known from 12 sites in Shasta County, California (Appendix J-2). The **Type Locality** is at Redding where the species was found in drift of the Sacramento River. It has been found generally in T. 34 S., R.1 to 5 W. and in the Redding area. Sites are expected to be found on Shasta National Forest lands and within the Whiskeytown-Shasta-Trinity National Recreation Area.

Refer to the Mollusk Survey and Manage Database for specific locations.

D. Habitat Characteristics and Species Abundance

T. tehamana has been found in shaded talus (rock piles), rockpiles along the bank of the Shasta River, and under leaf litter and other debris on the ground in adjacent forested habitats. *T. roperi* is expected to found in similar habitat, but appears to be more closely associated with limestone substrates. Rocks and large woody debris serve as refugia during the summer and late winter seasons. Temperature is lower and humidity is higher under talus than in the surrounding environment. While the specific food requirements of this species is not known, a variety of vegetation, subsurface roots, fungi, and organic debris is typically found in talus slopes. Small invertebrates that may serve as food

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sources also inhabit the talus environment. Forest litter and coarse woody debris in the semi-dry areas in which these species occur is considered necessary to provide food (shelter and substrate for fungi) and temporary cover when foraging.

Both of these species are rare, and known from few locations. Population density at known sites has not been determined.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage

According to the FEMAT report, the mollusk assessment suggests that the options considered in the outcome assessment were less effective in providing for mollusks than for any other species group. High degrees of endemism, rareness, and habitat specialization account, in part, for the low ratings. Under the selected management option (Option 9) for *T roperi*, there would be a 37% probability that the species would be well-distributed across Federal lands, a 30% probability that the species would remain viable but with gaps in distribution, a 27% probability that populations would be restricted to refugia, and a 10% probability that it would be extirpated. For *T. tehamana*, outcomes were assessed at a 40% probability that the species would be well-distributed across Federal lands, a 33% probability that the species would remain viable but with gaps in distribution, a 20% probability that populations would be restricted to refugia, and a 7% probability that it would be extirpated. (FEMAT Table IV-22).

Ratings for *T. roperi* reflect the distribution of known sites on matrix lands in areas outside of protection from Riparian Reserves. Ratings for *T. tehamana* reflect similar concerns, though some protection may result from Riparian Reserves.

B. Major Habitat and Viability Considerations

Maintaining refuge sites with appropriate microclimate conditions during the summer and winter within and around occupied habitat is considered critical. Retaining large woody debris, leaf litter, uncompacted soil, and canopy cover may assist in maintaining summer shade and refuge sites with respect to these habitat conditions. The small size of these species increases the difficulty of dispersal across hostile habitats.

The survival of mollusk species in semi-xeric (dry) conditions is especially dependent upon the presence of adequate refuge sites during the hot summer and cold winter months. An increase in temperature or decrease in moisture during the hot summer months is much more likely to adversely affect these subspecies than those that live in a mesic (moist) environment. The range of environmental conditions that these species can tolerate is not known, but desiccation is the most common cause of mortality for mollusks in general. These species are tolerant of drier conditions than are the subspecies of *Monadenia fidelis*, and seems to tolerate conditions similar to those that *Monadenia chaceana* survives.

The number of population sites required to maintain species viability is unknown; however, it can be assumed that the likelihood of species viability increases with the number of populations.

C. Threats to the Species

Given that little information is available about the habitat needs of the species, the following statements can be applied. In general, land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. Consequently, they are very vulnerable to management activities that increase temperature, decrease moisture, or decrease food supplies available in populated sites. Habitat alteration by either human or natural means (including fire, herbicide use, recreation development), over-collecting, and disturbance during aestivation may constitute major threats to these species.

Road building and substantial road maintenance were identified as specific issues of concern for *T. roperi* in Appendix J-2. For *T. tehamana*, occurrence outside of Riparian Reserves in matrix lands was identified as an issue of concern.

D. Distribution Relative to Land Allocations

T. tehamana is known from 2 sites on non-federal land, 2 sites in matrix federal land, and 2 sites outside of the range of the Northern Spotted Owl (Appendix J-2). *T. roperi* is known from 3 sites on non-federal land and 1 on federal matrix land. Another site is now under Shasta Lake (Appendix J-2). This species is also expected to be found within the Whiskeytown-Shasta-Trinity National Recreation Area.

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The management goal for this species is to maintain the species across the known range by avoiding actions that would degrade occupied habitat or adversely impact the viability of existing populations.

B. Specific Objectives

C Maintain uncompacted soil in and near populated sites.

- C Maintain undisturbed talus and rocky outcrops (most important in the lower third of the slope).

- C Maintain vegetative community and shading in the population area.

- C Maintain current volume of coarse woody debris as food sources (substrate for fungi) and refuge sites, and protect future sources of coarse woody debris.

- C Maintain soil temperature and moisture regime of the refugia sites (cool and moist during the summer). Identify and manage sites on public lands in accordance with Section IV C. to assist in maintaining the viability of these species throughout their ranges.

IV. HABITAT MANAGEMENT

A. Lessons from History

The range of these species was originally assumed to have been smaller than is now indicated by the range of currently known sites. The habitat characteristics identified here may be more or less restrictive than those required or used by either or both species. Care should be taken in surveying for these species to ensure that the activities do not inadvertently extirpate individuals or populations. Over-collecting has led to the extirpation of many species in Hawaii (Hadfield 1986). Fire management activities that increased the intensity, duration, or frequency of fire; forest management activities that affected shade; and road construction that directly disturbed sites, shading, or stability have significantly impacted other species in the Pacific Northwest.

As seen above, field research associated with any specific mollusk species often leads to the discovery of the species being found in different habitats than expected based on original species discovery. Range extensions are also common. This means that surveying for these species should include searching habitats beyond talus or rocky areas.

B. Identification of Habitat Areas for Management

As of August 1998, it is considered important to protect all known occupied sites on public lands due to the relative rarity of this species. The Habitat Area will be identified as the area around known site locations that includes all habitat features that contribute to environmental conditions important to the species at the known site. In most cases, this could be achieved by areas up to tens of acres (ROD C-5). As new data is compiled, consideration should be given to daily and annual movements within the life cycles of the organisms. Efforts should be made to connect Habitat Areas with other reserve areas such as Riparian Reserves in order to facilitate dispersal in protected habitats.

C. Management Within Habitat Areas

In general, manage all populated sites on public lands to provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus and vegetative cover. Adjacent forested areas should be managed to provide shade, coarse woody debris and uncompacted forest litter. Due to the rarity of known populations, sites should be protected from wildfire events.

Mitigation measures outlined in Appendix J-2 for *T. tehamana* stress the importance of the proper implementation of Riparian Reserves under option 9. Additions to Riparian Reserves should be considered when surveys locate the species outside of standard reserve areas. For *T. roperi*, surveys prior to road-building or major road maintenance are considered to be particularly important.

D. Other Management Issues and Considerations

Prescribed fire may be considered as a tool to be used to reduce the risk of catastrophic natural fire. Prescribed burning should be designed to avoid significant impacts to the habitat conditions in the management area as outlined in Section II-B.

Consideration should be given to locating and managing additional sites and determining the actual biogeography of the species.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

Present knowledge of these species is based on limited collecting from known population areas in the 1930s. Significant data gaps exist in our knowledge of the species' fossil record and its biologic and environmental needs. The species' present and former distribution, and the factors that have controlled distribution, diet, reproductive rates, and dispersal rates need further investigation. Local and range-wide population trends are not known.

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Field research associated with any mollusk species often results in detections in different habitats than expected based on prior knowledge. Range extensions are also common. Surveys outside of known habitat conditions may be helpful in determining the full range of habitat conditions in which the organisms can survive.

B. Research Questions

- What are the food requirements of these species, and are any of these food requirements unique to the species?
- What is the range of environmental conditions that these species can tolerate, and how long can extremes be tolerated?
- Are there other populated sites?
- What factors control the species' rate and distance of dispersal?
- What are the species' natural life spans?
- What adaptations have the species made that allow them to be more xeric tolerant than *Monadenia* species?
- What is the actual physical range of the species?
- How far does an individual range away from its refuge site?
- What is the population density of the known sites?
- What are the conditions that control the species viability at known sites?

C. Monitoring Needs and Recommendations

Known sites on public land should be monitored to assess population trends and to attempt to determine the factors that control those trends. Monitoring strategies should be designed to assist in determining if the implementation of the plan is resulting in the protection of habitat for these subspecies. In addition, monitoring should be designed to ensure that site disturbance or collection activities do not extirpate local populations.

VI. REFERENCES

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SECTION NO. 15
Vertigo n. sp.
Hoko Vertigo

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Management Recommendations For *Vertigo* n. sp., the Hoko Vertigo (land snail)

V. 2.0

by

John S. Applegarth

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EXECUTIVE SUMMARY

Species: *Vertigo* n. sp., the Hoko Vertigo (land snail)

Taxonomic Group: Mollusks

ROD Components: 1 and 2

Other Management Status: This unnamed species is on the Washington State Monitor Species List and, therefore, it is a Bureau of Land Management Tracking Species.

Range: This species is only known from 2 sites on the Hoko River in the northwestern part of the Olympic Mountains. These locations are on non-Federal lands, but are within 10 km (6 mi) of the Soleduck Ranger District (Olympic National Forest), and 20 km (12 mi) from parcels of Bureau of Land Management land along the Soleduck River in Clallam County. This species is suspected to occur in Clallam County in the Olympic National Forest.

Specific Habitat: The Hoko Vertigo seems to be an old growth associate and a riparian associate. The 2 known locations are on bases of wooded slopes near streams at the low elevations of roughly 12 and 90 meters (40 and 300 feet), but the species could occur at considerably higher elevations. The habitat seems to be characterized by old trees, riparian hardwoods, and mesic conditions. This species is arboreal and has been found on trunks and lower limbs of deciduous trees, mainly alders. They are most easily detected on the undersides of limbs and leaning trunks of young alders that have relatively smooth bark.

Threats: When a species is known from only a few locations, any modification of the environment could be a potential threat to its survival. Habitat factors that seem to be vulnerable include late-successional stands of riparian hardwoods and the associated microclimate, the stream stability, and the diverse community of native plants and animals. Threats to these habitats include silvicultural treatments in riparian areas, special forest product harvesting, recreation, and road construction.

Management Recommendations: If this rare species were to be found on Federal lands, the long-term survival of any newly discovered colonies should each be favored by conserving or attaining late-successional conditions within an identified Habitat Area. If interior microclimate needs to be conserved or attained, then the Habitat Areas may need to be as large as 24 hectares (60 acres). Allow natural attainment of stand heterogeneity. Avoid managing in Habitat Areas by means of fire or chemicals, and avoid concentrated recreation or other activities that could compact the ground or mechanically injure old hardwood trees.

Information Needs: The range and relative abundance of this apparently rare species need to be explored. More information on its habitat needs to be collected. Its ecology and tolerance to disturbance are largely unknown. The only known sites are on State land, so if any sites are found on Federal land, management should be cautious and results should be monitored.

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

The genus *Vertigo* is in the subfamily Vertigininae (e.g., Pilsbry, 1948, page 943), in the family Pupillidae (e.g., Burch and Pearce, 1990, page 241), and in the superfamily Pupilloidea, order Orthurethra, subclass Pulmonata, and class Mollusca (e.g., Smith et al. 1990).

The genus *Vertigo* was named by Müller (1774), who described a European species, *Vertigo pusilla* Müller, as the type species of this genus. According to Pilsbry (1948), this genus is known from most of the Holarctic realm from near sea level to 10,000 feet elevation, and it includes about 80 species. Pilsbry (1948) recognized 3 subgenera: *Angustula*, *Vertillaria*, and *Vertigo* (sensu stricto). Within the subgenus *Vertigo*, Pilsbry (1948) recognized 7 species groups. Frest and Johannes (1996b) placed the Hoko Vertigo into the *Vertigo californica* group. Sterki (1892) gave this group a subgeneric name, *Nearctula*, which was regarded as a synonym of the genus *Vertigo* by Pilsbry (1948). Recently *Nearctula* has been used by some authors as the valid genus for this species group (Smith et al. 1990; Turgeon et al. 1998).

This is a biological species that, as of January 1999, has not been formally named. Hence there is no type specimen nor type locality. Instead there is a morphologically distinct population of snails that is informally known as the Hoko Vertigo (an English or common name that was suggested by Frest and Johannes, 1993, page 43), as *Vertigo* n. sp. 1 (Frest and Johannes 1993), and as *Vertigo* n. sp. (USDA . . ., 1993, 1994b). Technically this is an unnamed species, not a new species, because the phrase "new species" is normally used only within the published formal proposal of a new taxonomic species.

There are no subspecies, and no taxonomic subdivision of this species is anticipated.

B. Species Description

1. Morphology

The Hoko Vertigo is a tiny snail. Adults have a shell that is about 2.5 mm (0.1 inch) in length, which is the greatest dimension. The shell is pupilliform or shaped like an insect pupa, vaguely cylindrical with rounded ends. As one of these snails grows, progressively more of the growth is downward (from the apex) and this results in a lengthening of the cylinder formed by the dextral spiraling of the shell (see illustrations of the *Vertigo californica* group on page 997 of Pilsbry, 1948). Burke (1994) noted that snails in the genus *Vertigo* usually have shells that are a brownish, dark amber to cinnamon brown. This description is consistent with a photograph (by Thomas E. Burke) of 2 shells of this species, which appear closer to amber brown than cinnamon brown.

The shell of the Hoko Vertigo was described by Frest and Johannes (1996b). They noted the shell to be relatively smooth and glossy. Because it has growth ribs that are low and irregular, it resembles *Vertigo rowellii* and is unlike *Vertigo californica* that has strongly pronounced ribbing. The single parietal lamella (or "parietal tooth") is fairly prominent, as in *Vertigo rowellii*. The columellar lamella is vestigial and higher on the columella than in *Vertigo rowellii*. In subadult shells the palatal and basal lamellae are short and multiple, and **in fully adult specimens the basal lamellae are fused laterally into a blade-like tooth (a key feature of this species)**. As with other members of the *Nearctula* group, there is no sinulus, crest, or depression over the palatal lamella. The umbilicus is open and relatively large for a *Vertigo*. The aperture (mouth) is distinctly flared, more so than in other members of this group, and barely reflected. The middle whorls of the shell are broader than the final whorl. A glossary of terms is in Frest and Johannes (1996b) and Furnish et al. (1997). In Pilsbry (1948, page 869; redrawn in Burch and Pearce, 1990, page 243) there is a labeled diagram of the lamellae of a pupillid snail (family Pupillidae).

2. Reproductive Biology

Land snails, including pupillid snails, are hermaphroditic and exchange gametes with other conspecific individuals when conditions are favorable. Land snails do not tend their young, which look like miniature adults. Pilsbry (1948, page 926) speculated that probably all pupillid snails are viviparous (ovoviviparous), and his figure 500 (on page 927) illustrates a pupillid uterus that is distended with at least 3 snail embryos. This suggests that the Hoko Vertigo does not lay eggs but instead retains the fertilized eggs and gives birth to small numbers of live young. The Hoko Vertigo is thought to be a short-lived species with a potential life span of less than 2 years. At any given time of year, the individuals in a colony of pupillid snails all seem to be at about the same stage of development (Terrence J. Frest, personal communication). Captive maintenance, as was done by Walton (1963, 1970) for a variety of snails in other families, has not been done for this species or for any other pupillid snail in order to determine potential longevity.

3. Ecology

Little is known about the ecology of the Hoko Vertigo, other than the available habitat descriptions and the observation that virtually all of individuals are arboreal. Very few have been found within leaf litter samples that were collected from under occupied trees, and those that

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were in the litter samples may have been there by accident (Terrence J. Frest, personal communication). In Northwest forests, pupillid snails overwinter on tree limbs, so presumably they are not killed by freezing temperatures (Terrence J. Frest, personal communication). Wrens feed mainly on insects, but the Winter Wren (*Troglodytes troglodytes*) may also predate on pupillid snails. Andrus (1897) reported that while collecting another species, *Pupa rowelli* [=*Vertigo rowelli*] in Douglas County, Oregon, he observed a Winter Wren "at work on a small myrtle" and when he went to that tree he found no examples of that snail although "there were plenty on adjoining trees."

C. Range, Known Sites

As stated in Appendix J2 (USDA . . ., 1994a), **the known range of the Hoko Vertigo consists of only two sites**, which are located along the east side of the Hoko River in Clallam County in the northwestern part of the Olympic Peninsula of Washington State. The Known Sites Database (version 2.0) contains only one record (ID 95300162 = Deixis location #2183), which is in the mouth of Blue Canyon at about 4.8 miles SW of the Washington route 112 turnoff and in the SE quarter of section 32, T. 32 N, R. 13 W, Willamette Meridian. The USGS topographic map (Hoko Falls, Washington, 1984) suggests this location is more likely to be in the SW quarter of the same section. The other site is along the Ozette Lake Road roughly 2 miles to the NE of Blue Canyon, and is in the SW quarter of section 22 close to the section line, T. 32 N, R. 13 W (Deixis location #3241). The land ownership of both locations is non-Federal (apparently both are owned by the State of Washington).

The elevational range of this species is not known. The two available records are from relatively low elevations, roughly 12 and 90 meters (40 and 300 feet). Although this snail is apparently dependent on riparian hardwoods, there is no reason to anticipate that this species does not occur in otherwise suitable situations that are at considerably higher elevations.

D. Habitat Characteristics and Species Abundance

Both known sites for the Hoko Vertigo are in riparian forests on the east side of the Hoko River. The habitat at one of the two known sites consists of second-growth Douglas-fir forest with a sizable component of bigleaf maple (Deixis location #2183). This site is near a stream and is at the base of a steep northwest-facing slope with seeps. Local vegetation includes liverworts, large sword fern, and maidenhair fern. The substrate is sedimentary rock, possibly of Oligocene age. The habitat at the other site is at the foot of a slope next to the Hoko River and is characterized by the presence of old hardwood trees. The presence of old riparian hardwood trees, especially old alders, seems to be important because searches for this species at other locations along the Hoko River where there were only young riparian hardwoods failed to detect this species (Terrence J. Frest, personal communication).

This tiny snail, like most pupillid snails, is arboreal and is most easily observed on the relatively smooth bark of small alders and other hardwood trees and bushes but occasionally is found on the trunks of mossy mature alders. Snails of this genus are often found on the underside of limbs, leaning trunks, and root sprouts. This preference for the underside of limbs may have a number of benefits such as avoiding the impact of raindrops, being shaded from sunbeams that come through the canopy, being less accessible to avian predators, and possibly finding more to eat on the dampest surface of each limb.

The snails of this species are reported to be rare where they are present (Frest and Johannes 1996a). To some extent this present rarity could be a result of changes to the structural habitat and microclimate. The USGS topographic map (Hoko Falls, Washington, 1984) shows an abundance of logging roads in this area (section 32), and the area is reported to have been extensively logged (Terrence J. Frest, personal communication). In samples of leaf litter collected from under inhabited trees, Frest and Johannes (1996a) found this species to be very rare and speculated it was probably present on the ground by accident.

In general, as noted by Andrus (1897) and Frest and Johannes (1996a), arboreal pupillid snails (family Pupillidae) seem to be naturally patchy in their distribution, with small to large numbers being found in some trees and none in nearby trees of the same species, age, and situation. This tendency of pupillid snails to have a patchy distribution may make it difficult to make estimates of population size and population trends in the Hoko Vertigo.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage Standard and Guideline

Presumably the Hoko Vertigo (land snail), *Vertigo* n. sp., was included in the list of Survey and Manage mollusks (USDA . . ., 1994b, page C-59) because (1) its distribution is within the range of the Northern Spotted Owl, (2) this species appears to be an old growth associate and, although only known from non-Federal lands, (3) there is a reasonable likelihood of its occurrence in the Clallam County parts of the Olympic National Forest. In the FEMAT analysis (USDA . . ., 1993, Table IV-22), the panel of experts decided that under Option 9 there is a 15 percent chance of this species becoming extirpated. This mollusk seems to have a very limited distribution, so activities that alter habitat features or microclimate at occupied sites should be viewed as threats to its survival.

B. Major Habitat and Viability Considerations

The preeminent habitat and viability consideration for this rare species is the conservation of existing populations by means of protecting their areas of occupied structural habitat and associated microclimate. When contrasted to vertebrate species, mollusk populations are relatively sedentary, and habitat connectivity is of little importance to their immediate survival. “If protected from catastrophes, snail colonies may not depend on immigration and could conceivably be self-sustaining for centuries, in which case the distance to the next fragment [of suitable habitat] may not be very important” (Roth 1993). “With the normal distribution of forest snails sometimes being so patchy, even small and isolated old growth fragments could be highly significant in preserving colonies until suitable habitat conditions are more widely available” (Roth 1993). What is important is to identify occupied sites and then conserve favorable habitat structure and conditions. However, it should also be recognized that this species depends on the health of the local ecosystem, which in turn depends on connectivity with adjacent communities, both terrestrial and aquatic.

C. Threats to the Species

Because the Hoko Vertigo seems to have a very limited distribution, any environmental alteration should be viewed as a possible threat. Most of the area surrounding the known sites has been recently logged (Terrance J. Frest, personal communication), so the most serious threat seems to be the possibility that the inhabited patches of older trees could be lost to timber harvest. Adjacent areas have young alders but they are not inhabited by this species (Terrance J. Frest, personal communication). The present populations may be stressed by being more exposed to wind and relatively dry air than would have been the case before the adjacent areas were logged. In addition to logging, presumably these islands of older riparian forest are also vulnerable to fire and damaging floods. Chemicals spilled or applied near inhabited areas could contribute to extirpation. Other possible threats could come from the disruption of the local ecosystem by nonnative species, such as predation by exotic birds, competition and disease from exotic mollusks, and degradation of arboreal substrates by exotic plants that will climb hardwood tree trunks. Special forest products activities such as collection of mosses and/or lichens from hardwood branches within occupied habitats also have the potential to adversely impact this species.

D. Distribution Relative to Land Allocations

There are no known sites for the Hoko Vertigo on Federal forest lands. The two known sites are probably on State lands. The nearest part of the Olympic National Forest is the Soleduck Ranger District, which is about 10 airline km (6 miles) to the southeast, and all of which is within Clallam County and the suspected range of this species. The Clallam County part of the Quilcene Ranger District is also within the suspected range of this species. There are small parcels of Bureau of Land Management land along the Soleduck River, roughly 20 airline km (12 miles) to the south. If any sites are found on Federal forest lands, they will probably be within Riparian Reserves.

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The goal for the management of the Hoko Vertigo (land snail), *Vertigo* n. sp., on Federal lands is to assist in maintaining the viability of this apparently rare and vulnerable species.

B. Specific Objectives

- Conserve or attain late-successional riparian forest conditions, including old alders and other identified elements.
- Conserve or attain favorable microclimate conditions at known sites.
- Manage to favor the stability of streams and adjacent slopes to prevent damage to occupied trees in Riparian Reserves.
- Avoid negative impacts of recreation and special forest product harvesting activities.

IV. HABITAT MANAGEMENT

A. Lessons from History

There seem to be no reports on any populations of snails in the genus *Vertigo* that have been observed over a range of time, or even over a range of environmental conditions, that provide any circumstantial evidence of a response to forest management activities.

B. Identification of Habitat Areas for Management

On the basis of the records and habitat information that were available as of August 1998, it is recommended that each newly discovered site for the Hoko Vertigo that is on Federal land and is defined with adequate precision should be protectively managed by means of an identified Habitat Area. The interagency ROD (USDA . . ., 1994b, beginning on the bottom of page C-4) advises that "in most cases, the appropriate action will be the protection of relatively small [Habitat Areas], on the order of tens of acres." For species that are known to be extremely rare, as this one seems to be, larger areas may be considered in order to fully account for the unknown variables in habitat that may limit the suitability of the area for the species. Chen et al. (1995) found that edge effects on air humidity and wind speed (measured at 2 meters above the ground) can extend over 240 meters (787 feet) into the forest. A circle with a radius of 240 meters encloses 18.1 hectares (44.7 acres). Therefore, if the identification of Habitat Areas for this rare and arboreal species is guided by the conclusions of Chen et al. (1995), then each Habitat Area may need to enclose as much as 24 hectares (60 acres) in order to ensure that the occupied location will continue to have interior climatic conditions after timber harvest in adjacent areas. As new data is compiled, consideration should also be given to daily and annual movements within the life cycles of the organisms.

C. Management Within Habitat Areas

Management within Habitat Areas identified for the conservation of newly discovered sites (colonies) of the Hoko Vertigo on Federal lands should use a cautious and protective approach. In general, the management within identified Habitat Areas should conserve or attain late-successional forest conditions. In spite of the fact that alders are shade-intolerant trees, and the observation that suitable habitat seems to include both young and old alder trees, there should be no planned reduction of canopy closure that could increase the exposure of these snails to the drying effects of sun and wind. Instead the desired heterogeneity of riparian hardwoods should be attained by natural processes. Existing canopy composition and closure should not be compromised by the alteration or removal of any trees, especially hardwood root sprouts and young trees that may be occupied by these snails. Removal or harvesting of mosses, lichens, or boughs should be prohibited within Habitat Areas. Although these snails are arboreal, any concentration of recreational activities or any activities that could substantially disturb or compact the soil should be avoided because they will not favor the health of the riparian hardwoods. Once old alder trees are mechanically injured, decay causing organisms can rapidly invade (Harrington 1990). There should be no management by means of fire or chemicals in identified Habitat Areas. Nonnative plants and animals should be controlled by mechanical or biological means, as needed. The threat from wildfire should be managed by the reduction of hazardous fuels in adjacent areas if there is adequate protection of Habitat Areas.

D. Other Management Issues and Considerations

As an arboreal species, the Hoko Vertigo is especially vulnerable to extirpation by fire. Forest management by means of prescribed fire should be done with great care near Habitat Areas for this species. Chemicals used in fire suppression may be harmful to this species. Watersheds that are inhabited by the Hoko Vertigo should be managed to conserve and promote the relative stability of stream flow and to avoid damaging floods and debris torrents.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

The most urgent need is for surveys that explore the range and relative abundance of the Hoko Vertigo. Its range may be limited to a few sites along the Hoko River, or this species could prove to be fairly widespread in the mountains of the Olympic Peninsula. Surveys should also gain information about the elevational and ecological distribution of this tiny snail. Hopefully surveys will also gain information about canopy composition, age, closure, and other conditions that contribute to the local ecosystem and microclimate. Although the suspected range of this species is limited to the Clallam County parts of the Olympic National Forest (Furnish et al. 1997), exploration for this species on non-Federal lands in the northwestern part of the Olympic Peninsula could also make important contributions to the conservation of this species.

B. Research Questions

How tolerant is the Hoko Vertigo to habitat disturbance from forestry activities?
How tolerant is this snail to disturbance by mollusk survey activities?
Which plants are important as arboreal substrates for this species?
What are the best seasons and weather conditions for finding this species?
Can this species be distinguished from local similar species in the field?

What does this snail eat, and what predators eat this snail?
How does this arboreal snail disperse to other trees and other areas?

C. Monitoring Needs and Recommendations

At this time there are no known sites for the Hoko Vertigo on Federal forest lands. When and if populations of the Hoko Vertigo are found on Federal lands, those populations should be monitored (1) to assess compliance with the Survey and Manage standard and guideline, (2) to evaluate the habitat impacts of activities and events in and near these locations, and (3) to verify the continued existence of this species within each of the identified Habitat Areas. As noted in section I-D (above), because of the tendency of pupillid snails (in the family Pupillidae) to have patchy distributions, it may be difficult to estimate population size and trends for colonies of this species. It is suggested that monitoring be limited to periodic tests to detect continued presence at each known location. Because this is an annual species, its population responses to environmental changes could be too rapid to detect let alone reverse locally, but the loss of the species at some sites could serve to indicate a need for modification of management at other sites where this species is still surviving.

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SECTION NO. 16
Vespericola pressleyi
Big Bar Hesperian

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Management Recommendations for *Vespericola pressleyi*, the Big Bar Hesperian (land snail)

V. 2.0

by

John S. Applegarth

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EXECUTIVE SUMMARY

Species: *Vespericola pressleyi* Roth, 1985 — the Big Bar Hesperian (land snail)

Taxonomic Group: Mollusks

ROD Components: Survey Strategies 1 and 2

Other Management Status: None

Range: *Vespericola pressleyi* is an apparently rare species with a known range limited to a small area in northern Trinity County of California. Four of the locations are within 1 km (0.6 mile) of Big Bar on the Trinity River, a fifth location is somewhere along Treloar Creek that joins the Trinity River at Big Bar, and a sixth location is a spring on the east side of Barnum Ridge and about 10 km (6¼ miles) northwest of Big Bar. All sites are within the administrative boundaries of the Big Bar Ranger District of Trinity National Forest. One site is within the Hayfork AMA.

Specific Habitat: *Vespericola pressleyi* seems to be restricted to permanently damp situations in the immediate vicinity of seeps, springs, and stable streams. A canopy of conifers or hardwood trees is present at known sites and probably contributes to a favorable microclimate. The type locality is a perennial seep under dense shade of alders and bigleaf maples. Known sites have an elevational range of 380 to 840 meters (1250 to 2760 feet).

Threats: Threats to the survival of this species include the degradation of habitat features and the microclimate they provide. Domestic livestock can have a major negative impact on habitat features. Removal of trees and woody debris can degrade habitat for this mollusk. Destabilization of seeps and streams can make the dampness around those sites less reliable. Mechanical disturbance, fire, applied chemicals, and nonnative species may also pose threats.

Management Recommendations: Occupied known and newly discovered sites on Federal land each should be managed to favor the survival of this apparently rare species by means of an identified Habitat Area. If conservation of the microclimate is a concern then a protective Habitat Area may need to be as large as 4 hectares (10 acres). Within riparian Habitat Areas, conserve or attain a favorable canopy of riparian hardwoods, conserve woody debris and herbaceous vegetation, and conserve the permanence and aquatic ecology of the spring or stream. Avoid negative impacts of grazing, chemicals, and fire within Habitat Areas, but in adjacent areas manage the threat of wildfire by reducing hazardous fuels. Visit poorly defined sites to determine presence of this species on Federal land and needed management actions.

Information Needs: The range, biology, and ecology of this species need to be explored, and known sites need to be monitored for management compliance and species survival. A key is needed that will easily separate this species from other *Vespericola* of northern California.

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I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Pilsbry (1939, 1940) and most subsequent authors have placed the genus *Vespericola* in the pulmonate snail family Polygyridae (e.g., Turgeon et al. 1998). A recent exception is Burch and Pearce (1990) who used the name Mesodontidae for this family and viewed Polygyridae as a junior synonym.

The genus *Vespericola* was named by Pilsbry (1939) as part of his revision of the Polygyridae that he based on anatomical characters. As noted by Pilsbry (1939, page xvi), “in almost all cases there are correlated shell characters by which the genera are readily recognized.” Pilsbry (1940) included 7 species plus 5 subspecies, 6 or more species have been named since then, others have been recognized or elevated from subspecies, and there are 15 or more unnamed species (Frest and Johannes 1996; Roth 1993, and personal communications). *Vespericola* is a large genus that apparently contains over 30 species.

Vespericola pressleyi was named by Roth (1985), who reported most of what is known about its range and ecology. The type specimen (California Academy of Sciences, CAS 038601) was collected on August 4, 1983 by Barry Roth on the south bank of the Trinity River at 0.2 km (0.12 mile) east of the mouth of Price Creek, Trinity County, California. This location, the type locality, is in the SW/4 of the NE/4 of section 5, T. 33 N, R. 12 W, Mount Diablo Meridian, and is across the river and a quarter km east of the Big Bar Ranger Station.

There are no subspecies, and no division of this species is anticipated.

The English name for this land snail is the Big Bar Hesperian (Turgeon et al. 1998). An earlier name was the Pressley Hesperian (Turgeon et al. 1988)

B. Species Description

1. Morphology

Because there are many species in the genus *Vespericola*, including some that have not been described yet, the identification of specimens will be difficult and best done by an expert on this group or a person trained by such an expert. The following description of the morphology of *Vespericola pressleyi* was provided by Roth (1985, 1996). The shells have the size, shape, and tiny bristles that are fairly typical of this genus. The shells of adult examples, which can be recognized as mature by the presence of a thickened peristome (or lip) that flares outward, are 12.4-17.5 mm in diameter, with a mean of 14.3 mm, according to Roth (1996). In contrast to Pilsbry (1939, page xi), Roth measures snail shell diameters without including the flared peristome or adjacent constriction.

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According to Roth (1996), the shape of the shell of *Vespericola pressleyi* is depressed-helicoid, with 5.5-6.4 whorls. The spire is straight-sided or slightly convex, and the suture is deeply impressed. The periphery above the middle whorl is rounded or subangular, and sloping toward the base. Of the embryonic part of the shell, the first 0.2 whorl is obscurely granulose, the next 0.8 whorl has papillae in radial rows, and thereafter the embryonic shell has radiating, sometimes partly papillose wrinkles. The post-embryonic sculpture consists of low, retractive collabral rugae. The periostracum bears short, rather sparse, diagonally arranged bristles that mostly curve away from the direction of coiling. The surface between bristles has very fine, wavy, raised spiral lirae that are most evident on the base. The base is somewhat excavated around umbilicus and irregularly papillose; there are a few papillae in the umbilicus; and the inner base of the body (or outer) whorl is spirally corrugated behind the lip. The diameter of the umbilicus divided into the diameter of the shell equals about 8.5. The body whorl is not markedly descending, but is constricted and somewhat apico-basally flattened behind the lip. The aperture (or mouth of the shell) is broadly ear-shaped; the plane of aperture is at angle of 40E to the shell axis. The lip is turned outward and reflected (or turned back), especially at the base; the inner part of the basal lip sometimes has a faint, elongate, tubercular thickening. No parietal lamella (or "tooth") is present. The inner lip is angled forward and not markedly dilated over the umbilicus.

The color of the periostracum of a *Vespericola pressleyi* shell is brown. The lip of a mature shell (which is not covered by the periostracum) is pinkish buff to whitish. The body of the living snail is charcoal gray with a pinkish buff undertone; the mantle collar is a light gray. The mantle is about 70% covered with black spots.

Vespericola pressleyi is primarily defined by its anatomy. The atrium is short. The penis is long, with the lower 40-50% contained in the penial sheath; the upper portion is slender. The spermatheca is lunate, pointed at the end, and has a stout, thick-walled duct. Roth (1996) provided a key to separate this species from *Vespericola shasta* and a paragraph to separate this species from *Vespericola rothi*, but at this time there is no comprehensive key to separate this species from all of the other species of *Vespericola* that occur in northern California. Roth's key, paragraph, and glossary of terms are repeated in Furnish et al (1997).

2. Reproductive Biology

Although the reproductive anatomy of *Vespericola pressleyi* was described by Roth (1985, 1996), the reproductive behavior of individuals and resilience of populations (how fast populations can recover) seem to be unknown. There seem to be no reports on generation time,

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seasonality of reproductive activity, the number and appearance of the eggs, or situations used for oviposition. Captive maintenance, as was done for snails in other genera by Walton (1963, 1970), could provide guidance on potential longevity. Walton's results indicate that snails in *Ashmunella*, another genus in the family Polygyridae but in a different subfamily, can live 8 or more years. It would favor the stability of *Vespericola pressleyi* populations if individual snails live for several years after maturing and have multiple opportunities to reproduce.

3. Ecology

Other than the available notes about their habitat, essentially nothing is known about the ecology of *Vespericola pressley*. Other species in this genus seem to favor damp situations on the floor of the temperate forests of the Pacific Northwest. Adequately mesic situations within the range of this species seem to be limited to the immediate vicinity of springs and streams. Often snails in this genus are associated with rotten wood, with which their brown color can blend well when they are active in the open on cool and wet days. Other snails in this genus are herbivorous and captive specimens will eat herbaceous vegetation (John Applegarth, personal observations). They have also been observed to graze on the surface of lichens in a way that suggests they are consuming the algal part of the lichen (Nancy Duncan, personal observation).

C. Range, Known Sites

The Big Bar Hesperian, *Vespericola pressleyi*, is an apparently rare species that is only known from a small area in northern Trinity County, California. This species has been reported from 6 locations that are detailed in Appendix A (below). The Known Sites Database (version 2.0) has 19 records for this species, and all of those records seem to be valid. Thirteen of the records are for the type locality, which is 0.2 km (0.12 mile) east of Price Creek on the south side of the Trinity River at Big Bar (the multiple records represent specimens at various museums or specimens collected on different dates). Of the remaining 6 records, 3 are for the mouth of Manzanita Creek just east of Big Bar, and 1 is for the south side of the Trinity River just south of Big Bar. One location not in the Known Sites Database is the south side of the Trinity River opposite the mouth of Manzanita Creek. Together these 4 locations are all within 1 km (0.6 mile) of Big Bar. A fifth location is Treloar Creek, a stream that joins the Trinity River at Big Bar but is about 5 km (3 miles) long. A spring on the east side of Barnum Ridge is the sixth location, which is about 10 km (6¼ miles) northwest of Big Bar. All known locations are within the administrative boundaries of the Big Bar Ranger District of Trinity National Forest (administered as Shasta-Trinity National Forests). The range of this species is not expected to extend beyond the adjacent districts, which include the Hayfork and Weaverville Ranger Districts of Trinity National Forest (including the Hayfork AMA), the Lower Trinity Ranger District of Six Rivers National Forest, and the Redding Resource Area (Trinity County only) of NorCal Bureau of Land Management.

D. Habitat Characteristics and Species Abundance

Vespericola pressleyi seems to exist in isolated colonies of small to moderate numbers (see Appendix A). All species in the genus *Vespericola* seem to favor damp situations. Relative to other kinds of snails, Barry Roth (personal communication) informally refers to snails in the genus *Vespericola* as “water babies.” Although this and other species of *Vespericola* in northern California may move away from streams during wet weather, at least during the dry parts of the year they seem to be limited to the reliably damp margins of seeps and small streams. In northern California, snails in this genus seem to associate with any available cover, including decaying hardwood leaves, woody debris, and loose rocks. At the type locality, snails of this species were active on damp moss and fallen bigleaf maple leaves around a perennial spring seep (Roth 1985). This site was shaded by a dense canopy of red alder and bigleaf maple. Because the Trinity River is now regulated by upstream dams that divert most of the water to the Central Valley, these snails presently may be able to inhabit riverbank seeps that otherwise might have been seasonally flooded, including the type locality. At the site on the east side of Barnum Ridge, the snails were associated with a spring in a relatively open stand of Douglas-fir.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage Standard and Guideline

Although *Vespericola pressley* can be moderately common where it occurs, this snail is known from few sites and seems to have a small geographic range, so this species seems relatively vulnerable to extinction if there were adverse modifications of inhabited locations. In the FEMAT report (USDA . . ., 1993, page IV-129) this species was judged to have a 10% risk of extirpation under Option 9. The range of this species is entirely within the range of the Northern Spotted Owl. At least one and possibly several of the known locations are under the management of the Shasta-Trinity National Forests. This small land snail seems to be dependent on riparian conditions associated with coniferous forests that are largely under Federal management. This species should benefit from the Riparian Reserves standard and guideline, but the Survey and Manage standard and guideline is an additional precaution because this species seems to be rare and vulnerable to extinction. Impacts from grazing within riparian areas adds further justification for the protection of known sites.

B. Major Habitat and Viability Considerations

The preeminent habitat and viability consideration is the conservation of existing colonies of *Vespericola pressley* by means of positive management of identified patches of habitat. When contrasted to vertebrate species, mollusk populations are relatively sedentary, and habitat connectivity is of little importance to their immediate survival. "If protected from catastrophes, snail colonies may not depend on immigration and could conceivably be self-sustaining for centuries, in which case the distance to the next fragment [of suitable habitat] may not be very important" (Roth 1993). What is most important is to identify occupied locations and then to maintain appropriate structures and conditions. However, it should also be recognized that this species depends on the health of the local ecosystem that in turn depends on connectivity with adjacent communities, both terrestrial and aquatic. Sedentary species such as this one are especially vulnerable to concentrated impacts that can occur in riparian areas within otherwise xeric environments.

C. Threats to the Species

For a mollusk species with such a limited distribution as *Vespericola pressleyi*, any degradation of habitat features and microclimate could be a threat to its survival. Domestic livestock can threaten the survival of this species in a number of ways, including (1) the trampling of snails that are within the leaf litter or soil, (2) the reducing of the supply of herbaceous plants on which this species may feed, (3) the consuming of tree seedlings that are needed to provide future canopy trees, (4) the degradation of the water quality and the aquatic ecosystem, and (5) the degrading of perennial subsurface dampness because removal of vegetation by domestic livestock is likely to result in faster runoff and more solar energy striking and heating the ground. Other threats to this species could come from the removal of trees that provide shade, leaf litter, woody debris, and a windbreak. This snail may be adversely affected by the removal of loose objects on the ground, such as rocks and woody debris, that snails may need for cover. These snails seem to depend on the availability of damp substrate, so any substantial change to the local hydrology that results in decreased flow or increased instability of streams could threaten the local population of this snail. Mechanical disturbance by motor vehicles and concentrated recreational activities could contribute to extirpation by crushing snails and degrading needed habitat structures. The direct impacts of fire on mollusks tend to be negative. Fire can temporarily reduce the availability of shading vegetation, herbaceous plants, leaf mold, and woody debris. On the other hand, if hazardous fuels are reduced by prescribed fires outside of inhabited locations, that should reduce the threat to this species from wildfire. Applied chemicals, including firefighting chemicals, fertilizers, herbicides and pesticides, may be directly toxic to this species. Invasions by nonnative plants and animals could directly or indirectly threaten the survival of this species.

D. Distribution Relative to Land Allocations

As of August 1998 all of the known locations for *Vespericola pressleyi* are within the administrative boundaries of Trinity National Forest. Of the six known locations (Appendix A), four are within the Wild and Scenic Area along the Trinity River but only two of those locations (#2 and #5) are possibly on Federal land. One location was poorly defined (#3), and one location (#4) is definitely on Federal land and within the Hayfork Adaptive Management Area.

III. MANAGEMENT GOAL AND OBJECTIVES

A. Management Goals for the Taxon

The goal for management of the Big Bar Hesperian, *Vespericola pressleyi*, is to assist in maintaining the viability of known and newly discovered populations of this species.

B. Specific Objectives

Specific objectives for managing occupied known and newly discovered sites for *Vespericola pressleyi* on Federal land should include the following.

- Identify an adequate size and shape of an area for managing each site.
- Conserve the cool and shady micro climatic conditions as needed.
- Conserve the availability of woody debris, rocks, and leaf mold.
- Conserve the availability of herbaceous plants, moss, and ferns.
- Conserve the perennial nature of the local spring or stream.
- Conserve the quality and quantity of the water and the health of the aquatic ecosystem.
- Avoid possible harm from chemicals, fire, and non-native species.

IV. HABITAT MANAGEMENT

A. Lessons from History

There seem to be no reports on populations of *Vespericola pressleyi* or any other species in the genus *Vespericola* that has been studied over a range of time, or over a range of environmental conditions, so that inferences could be drawn concerning population responses and limiting environmental factors.

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B. Identification of Habitat Areas for Management

On the basis of the records and habitat information that were available as of August 1998, it is recommended that each occupied known or newly discovered site for *Vespericola pressleyi* that is on Federal land and is defined with adequate precision should be protectively managed by means of an identified Habitat Area. The Habitat Area will be identified as the area around known site locations that includes all habitat features that contribute to environmental conditions important to the species at the known site. The interagency ROD (USDA . . ., 1994, beginning on the bottom of page C-4) advises that "in most cases, the appropriate action will be the protection of relatively small [Habitat Areas], on the order of tens of acres." Chen et al. (1995) found that in riparian areas on south-facing edges the effect on soil temperature could extend 60 meters into the forest, and the soil moisture could be reduced 90 meters into the forest. If the conservation of microclimate at ground level is a concern, then the Habitat Area may need to be as large as 4 hectares (10 acres) in order to provide interior conditions at the known site. This particular species already seems to be challenged by natural conditions, so it is suggested that Habitat Areas may need to be larger in order to fully account for the unknown variables in habitat that may limit the suitability of the area for the species. However, if the landscape outside of the Riparian Reserve does not currently or can be reasonably expected to positively contribute in the future to the microclimate at ground level where the snails are living, then there may be no need to include it and instead it may be preferable to identify a Habitat Area for this species within the Riparian Reserve boundaries to provide the required favorable environmental conditions, structural features, vegetation, and water quality at occupied locations. The width and length of such a Habitat Area should be guided by concerns for shading and wind buffering and could approximate the width of the Riparian Reserve unless greater distances are needed or a dimension must be limited to less because of land ownership or paved roads. Such a riparian Habitat Area should extend far enough upslope to adequately protect the spring or seep at the occupied location and provide adequate environmental conditions at known sites, or far enough upchannel to adequately protect the water quality and aquatic ecosystem of a stream reach where this species is known to live along the stream margins. As new data is compiled, consideration should also be given to daily and annual movements within the life cycles of the organisms.

C. Management Within Habitat Areas

Management within Habitat Areas identified for the conservation of occupied known and newly discovered sites (colonies) of *Vespericola pressleyi* should use a cautious and protective approach. Maintenence of existing environmental conditions should include the following recommendations:

Prevent reduction of the existing canopy closure that could increase the exposure of these snails and their habitats to the drying effects of sun and wind. The structural composition of riparian hardwoods should be conserved or attained by natural processes.

Prohibit activities, including grazing by livestock and concentrated recreational activities, that could substantially degrade the herbaceous vegetation or water quality, reduce the quality or quantity of woody debris, disturb ground cover, or compact the soil at known locations.

Vehicles, horses, and livestock should be routed away from identified Habitat Areas in order to avoid crushing snails or degrading the quality of their habitat. If needed, suitable fencing should be constructed and maintained around Habitat Areas. Because all locations are below 1000 meter (3281 feet) elevation, the use of permanent fencing is preferable (if drop-fences were to be used, cattle might arrive before the wires were put up in the spring).

Management by means of fire or chemicals within Habitat Areas should be avoided, but the threat of wildfire to Habitat Areas should be managed by prescribed fire in adjacent areas.

Nonnative plants and animals should be removed by mechanical or biological means.

Activities within occupied watersheds, which may alter the rate of flow at occupied spring and seeps, should be regulated.

D. Other Management Issues and Considerations

There are two locations near Big Bar (#2 and #5 in Appendix A) that may be on Federal land. Because this is a rare species, it is recommended that those locations, plus any newly discovered locations with less than precise location definition, be visited to verify the presence of this species and to identify the appropriate size and shape of the Habitat Area needed to protect those sites.

The known populations of this rare snail seem to be isolated, so the complete burning of an inhabited riparian corridor could result in the extirpation of a colony of this species. The chance of this species locally surviving may be proportional to the extent to which parts of the riparian corridor were missed by a wildfire. However, it should be noted that chemicals used in fire suppression (detergents, etc.) may be directly harmful to this and other mollusks.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has

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not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

The Big Bar Hesperian, *Vespericola pressleyi*, has not been the subject of any special study. There are no keys or guides for distinguishing it from all other species of *Vespericola*. The distribution of this species is poorly explored, and its life history and ecological relationships are largely unknown. If additional discoveries of this species are made on Federal lands, the details about the location and habitat could substantially contribute to a better understanding of this species. If additional sites are found and managed on Federal lands, then the risk of the accidental loss of any populations, known or unknown, becomes less of a threat to the viability of the species. Surveys may find this species to be limited to a few locations, or it may be broadly distributed along the streams of the region. The range of this species should become better defined by mollusk surveys in the Big Bar, Hayfork, and Weaverville Ranger Districts of Trinity National Forest, the Bureau of Land Management land within Trinity County, and the Lower Trinity Ranger District of Six Rivers National Forest.

B. Research Questions

Does *Vespericola pressleyi* occur together with other species of *Vespericola*?
What is the geographic and elevational distribution of this species?
Does this species favor areas with alkaline rock in the alluvium?
What are the preferred foods and major predators of this small snail?
What methods might help in the detection and monitoring of this snail?
How long can individual snails of this species live (as tested in captivity)?
Can any plants serve as indicators of the possible presence of this snail?
To what extent did the historic gold mining impact this species?
To what extent has grazing by livestock impacted this species?

C. Monitoring Needs and Recommendations

Known and newly discovered locations for *Vespericola pressleyi* should be monitored (1) to assess compliance with the Survey and Manage standard and guideline, (2) to evaluate the habitat impacts of management activities near these locations, and (3) to verify the continued existence of this species within each managed location. It is suggested that monitoring be limited at most locations to detecting presence and only when season and conditions are favorable for protocol surveys for terrestrial mollusks. Although rocks, woody debris, and leaf mold should be replaced as much as practicable, the limiting of monitoring to detecting presence is intended to minimize any degrading of the habitat.

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APPENDIX A

Following is an annotated list of the 6 known locations for the Big Bar Hesperian (land snail), *Vespericola pressleyi*. The first location is the type locality, and the rest are arranged by the first date they were visited. After the location number (and the record ID number or numbers from the Known Sites Database) there is a brief description of the location, followed by the date(s) of collection and number of specimens (plus the museum acronym or name of specimen holders and their catalog numbers, if any). The added annotation includes any corrections or questions, an estimate of the UTM coordinates, an estimate of the elevation, the name of the USGS 7½-minute topographic map, an estimate of the land ownership, and the level of precision code (plus the original code if one or more of the database records had a level that seems incorrect). In the Known Sites Database all records were graded as to how accurate the description of location seemed to be, and a letter code was entered in the "precision" field. The codes are S = "second record" (location description is accurate to ±150 feet), M = "minute record" (accurate to ±1.5 miles), G = "general record" (accurate to ±5 miles), and V = "vague record" (cannot be located within ±5 miles).

#1 (record ID 90033595, 95000067, 9500073-95000076, 97000022, 97500020, 97500064, 97600025-97600028) **Type locality** — California, Trinity County, south bank of the Trinity River at **0.2 km east of the mouth of Price Creek**, in SW/4 of NE/4 of section 5, T. 33 N, R. 12 W, Mount Diablo Meridian. 1981 October 3, 1983 August 4, and 1984 May 15. Over 50 specimens (California Academy of Sciences CAS 38601 — holotype, CAS 37057, 38602-38603; ANSP 360008; FMNH 205868; SBMNH 34281; USNM 859127; Roth 1401-1402, 1436-1437, and unnumbered). On the first visit a large number of shells were collected from under blackberry vines on a dry cut bank above the unpaved road, on the second visit a number of live snails (adequate for characterizing the anatomy of this species) were collected from the margins of a seep between the road and the river, and a small number were collected on the third visit; this is also a known site for *Ancotrema voyanum* (record ID 95000066); UTM are about 479060 E and 4509550 N; elevation is about 370 meters (1214 feet); USGS map = Hayfork Bally, CA, 1982; land ownership seems to be private; and precision = S (not M).

#2 (95000072, 97000021, 97000104) California, Trinity County, **Manzanita Creek**, east of Big Bar. 1942 summer, 1953 July 13, 1954, and no date. Fifteen or more specimens (CAS 53469, SBMNH 25403, Roth 1090, and specimens collected in 1953 and reported in Roth, 1985). Side road access exists only near the mouth of Manzanita Creek so this location is presumed to be adjacent to California Route 299; UTM are roughly 479500 E and 4509700 N; elevation is about 380 m (1247 ft); USGS map = Hayfork Bally, CA, 1982; land ownership is apparently Federal (Shasta-Trinity National Forests); and precision = M (not S).

#3 (95000077) California, Trinity County, **Treloar Creek**. 1980. One specimen (Roth 1185). This shell, found by Gay L. Berrien of the Big Bar Ranger Station, brought the existence of this species to the attention of Barry Roth; because this stream passes close to the ranger station it is tempting to speculate that this shell was found close to the station and thus close to the Trinity River, which would be consistent with other nearby sites also being close to the river; however, Treloar Creek is roughly 5 km (3 miles) long and this shell could have been found anywhere along this stream, so precision = G.

#4 (95000071) California, Trinity County, **east of Barnum Ridge**, springs by Forest Service road 5N16, in SE/4 of SE/4 of section 7, T. 5 N, R. 8 E, Humboldt Meridian. 1980 August 30. Twenty five specimens (Roth 1201). About 5.37 km west and 8.52 km north of Trinity River bridge at Big Bar; UTM are about 473420 E and 4518090 N; elevation is about 841 m (2760 ft); USGS map = Del Loma, CA, 1982 (no section lines); land is Federal (Shasta-Trinity National Forests); and precision = S (not M).

#5 (not in version 2.0) California, Trinity County, **opposite mouth of Manzanita Creek**, south bank of Trinity River, in NE/4 of section 5, T. 33 N, R. 12 W. 1981 May 29. Unknown number (reported in Roth, 1985). UTM are roughly 479500 E and 4509500 N; elevation is about 375 m (1230 ft); USGS map = Hayfork Bally, CA, 1982; land ownership appears to be Federal (Shasta-Trinity National Forests); and precision = M.

#6 (95000070) California, Trinity County, **south side of the Trinity River near Big Bar**. 1992 August 10. Five specimens (Roth 1815). UTM are roughly 479000 E and 4509500 N; elevation is about 375 m (1230 ft); USGS maps = Hayfork Bally and Big Bar, both CA, 1982; land ownership could be private or Federal; and precision = M.

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SECTION NO. 17
Vespericola shasta
Shasta Hesperian

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Management Recommendations for *Vespericola shasta*, the Shasta Hesperian (land snail)

V. 2.0

By

John S. Applegarth

February 1999

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EXECUTIVE SUMMARY

Species: *Vespericola shasta* (Berry, 1921) — the Shasta Hesperian (land snail)

Taxonomic Group: Mollusks

ROD Components: Survey Strategies 1 and 2

Other Management Status: None

Range: The distribution of *Vespericola shasta* is entirely within the range of the Northern Spotted Owl. This small land snail is known from seven locations in Shasta County of northern California. Six of the known locations are within the administrative boundaries of Shasta National Forest, but only one location is actually on Federal land. There is a reasonable possibility that this species may be found along other streams in Shasta County on lands managed by the Forest Service and the Bureau of Land Management.

Specific Habitat: *Vespericola shasta* inhabits damp ground at the margins of streams where it can find cover under loose rocks, woody debris, or decaying leaves. The original distribution of this species may have been influenced by the availability of limestone in the alluvium of the tributaries of the upper Sacramento River system. The available records are in the elevational range of 244-853 meters (800-2800 feet), but this species could occur both higher and lower.

Threats: Possible threats to the local survival of *Vespericola shasta* include loss of favorable microclimate through reduction or removal of riparian trees, the mechanical disruption of inhabited sites (by motor vehicles and earth-moving machinery), chemical pollution, invasion of the local ecosystem by nonnative plants and animals, and extensive removal of vegetation from watersheds that results in destructive floods and the loss of surface flow.

Management Recommendations: Known and any newly discovered sites on Federal land should be managed to favor the survival of this apparently rare species by means of an identified Habitat Area. Within riparian Habitat Areas, conserve or attain a favorable canopy of riparian hardwoods, conserve woody debris and herbaceous vegetation, and conserve the permanence and aquatic ecology of the spring or stream. Avoid negative impacts of grazing, chemicals, and fire within Habitat Areas, but in adjacent areas manage the threat of wildlfire by reducing hazardous fuels.

Information Needs: Surveys need to explore the geographical and ecological distribution of this rare species. Surveyors need a key or guide to all the species of *Vespericola* in northern California. Monitoring needs to verify management measures and local survival of this snail.

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I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Pilsbry (1939, 1940) and most subsequent authors have placed the genus *Vespericola* in the pulmonate snail family Polygyridae (e.g., Turgeon et al. 1998). A recent exception is Burch and Pearce (1990) who used Mesodontidae for this family and viewed the name Polygyridae as a junior synonym.

The genus *Vespericola* was named by Pilsbry (1939) as part of his revision of the Polygyridae based on anatomical characters. As noted by Pilsbry (1939, page xvi), "in almost all cases there are correlated shell characters by which the genera are readily recognized." Pilsbry (1940) included 7 species plus 5 subspecies, 6 or more species have been named since then, others have been recognized or elevated from subspecies, and there are 15 or more unnamed species (Frest and Johannes 1996; Roth 1993 and personal communications). *Vespericola* is a large genus that apparently contains over 30 species.

The English name for this land snail is Shasta Hesperian (Turgeon et al. 1998). The Shasta Hesperian was originally named as a subspecies, *Polygyra columbiana shasta*, by Berry (1921). Pilsbry (1928) elevated it to a full species, *Polygyra shasta*, and then Pilsbry (1940, page 903) moved it to the genus *Vespericola*. The type specimen (Santa Barbara Museum of Natural History, SBMNH 34131, formerly 5089 in the Berry Collection) was collected by Allyn G. Smith in August 1921 [or 1920?] "almost in the water under sticks and stones" near Lamoine, Shasta County, California. This is the type locality. Cordero and Miller (1995) suggested a restriction of the type locality to lower part of Little Slate Creek, one of two streams that flow into the Sacramento River at Lamoine. Although they found this species along both streams, this restriction was based on Berry's description of the type locality and on the greater similarity of the shells from that stream to the type series.

There are no named subspecies and none are anticipated.

B. Species Description

1. Morphology

Because there are many species in the genus *Vespericola*, including some that have not been described, the identification of specimens will be difficult and best done by an expert on this group or a person trained by such an expert. *Vespericola shasta* is illustrated by 3 black-and-white photographs of the type specimen in Cordero and Miller (1995). Roth (1996) provided the following description of the shell and soft parts of *Vespericola shasta*. This description was repeated in Furnish et al. (1997). For a glossary of terms, see Furnish et al. (1997).

"The shell of a mature *Vespericola shasta* should be in the range of 12.7-14.5 mm in diameter. In contrast to Pilsbry (1939, page xi), Roth measures snail shell diameters without including the flared peristone or adjacent constriction. The shell of this species is a depressed-helicoid and has 5½ to 6 whorls. The spire is straight-sided or weakly convex, and the suture is moderately impressed. The periphery above the middle of the last whorl is rounded or subangular and sloping toward the base. The first half whorl of the embryonic part of the shell is irregularly granulose, and thereafter the embryonic shell has fine, radiating, and sometimes partly papillose wrinkles. The post-embryonic sculpture consists of retractive collabral striae with minute overall granulation. The granules are axially elongated, close-set, parallel to the growth striae, and giving way after about the third whorl to irregular collabral wrinkling. The periostracum is shiny, especially on the base. The bristles, which are often well developed on other species in this genus, are minute and stubble-like, or absent. The base is tumid and solid-looking. The diameter of the umbilicus divided into the diameter of the shell equals about 10. The body whorl is not markedly descending, but it is constricted or compressed behind the lip. The aperture is broadly ear-shaped; the plane of the aperture is at an angle of 40E to the shell axis. The lip is turned outward and thickened within, especially at the base. A parietal lamella is usually absent but occasionally a trace is present. The inner lip is angled forward, moderately dilated, and covers half or less of the umbilicus. The periostracum is brown with an olive or pinkish tint, and the lip is pinkish buff to whitish.

"*Vespericola shasta* is primarily defined anatomically. This species differs from two recently described species that also occur in this region. *Vespericola scotti* Cordero and Miller (1995) has a minuscule verge at the insertion of the epiphallus into the penial chamber, about 0.1 mm in height and insufficiently long to converge into a conical tip. The penis is stout, protrudes extensively from the penial sheath, and is recurved at the upper end. *Vespericola rothi* Cordero and Miller (1995) has a short, conical, pointed verge 0.5 mm long and 0.5 mm wide at the base, with the seminal duct opening into the penial chamber at the cleft tip of the verge. The penis is cylindrical and protrudes extensively from the penial sheath, but the upper end is not recurved. *Vespericola shasta* has a minuscule, pointed verge that is 0.2-0.3 mm long, 0.2-0.3 mm wide at the base, and has the seminal duct opening at the cleft tip of the verge. The penis is entirely contained within the penial sheath, and the sheath also encloses a portion of the proximal epiphallus. Unfortunately, the shells of all three of these species are very similar."

2. Reproductive Biology

The reproductive anatomy of *Vespericola shasta* was described by Cordero and Miller (1995, figures 10-11) and Roth (1996 and above). The reproductive behavior of individual snails and the resilience of populations seem to be entirely unknown. For this species there seem to be no reports on potential longevity, generation time, season of reproductive activity, number and appearance of the eggs, or situations used for oviposition. The captive maintenance of live snails, as was done for other genera by Walton (1963, 1970), could provide guidance on potential longevity in this species. Walton found that snails in the genus *Ashmunella*, which is also in the family Polygyridae but in a different subfamily, can live 8 or more years. It should favor the stability of populations of *Vespericola shasta* if individual snails can live long enough to have multiple opportunities to reproduce.

3. Ecology

Nothing is known about the ecology of *Vespericola shasta* other than the available anecdotes about its habitat. Other species in this genus are more or less common on damp forest floors in the Pacific Northwest. Adequately damp situations within the range of this species generally seem to be limited to the immediate vicinity of springs and streams. Relative to other kinds of snails, Barry Roth (personal communication) informally refers to snails in the genus *Vespericola* as "water babies." Although snails in this species may move away from streams during wet weather, at least during the dry parts of the year they seem to be strictly limited to the reliably damp margins of seeps and small streams.

Other snails in the genus *Vespericola* are often associated with rotten wood with which their brown color blends well when they are active in the open on cool and wet days. Pilsbry (1940, page 575) stated that the food of polygyrid snails is chiefly the mycelia of fungi. Captive snails of other *Vespericola* will eat herbaceous vegetation (John Applegarth, personal observations), and they have been observed to graze on the surface of lichens (pieces fallen from trees) in a way that suggests they are consuming the algal part (Nancy Duncan, personal communication).

C. Range, Known Sites

The distribution of *Vespericola shasta* is within the range of the Northern Spotted Owl, including the Burney Falls location (contrary to a statement in the Known Sites Database with record ID 97500065). As of August 1998, this small land snail was known from only 7 locations (detailed in Appendix A), all within the watershed of the upper Sacramento River and all in Shasta County, California. Although Appendix J2 (USDA . . ., 1994a, page 341) indicates this species occurs in both Trinity and Shasta counties, there are no records on hand that suggest this species occurs outside of Shasta County. Six of the historic locations for this species are within the administrative boundaries of Shasta National Forest (administered as Shasta-Trinity National Forests) but **only one location is known to be on Federal land** (location #6). Two locations are within the Shasta National Forest but are too poorly defined to estimate land ownership, and 3 are on non-Federal lands within the Shasta National Forest boundaries. The remaining location (#3) is on non-Federal land that is just outside of the Shasta National Forest boundaries. Although there are other species in this area (Cordero and Miller 1995), there is a reasonable possibility that this species may be found along other streams on Federal lands within Shasta County, including lands managed by the Forest Service and the Bureau of Land Management. The 6 non-Federal locations are all within 1.6 km (1 mile) of Federal lands. Appendix J2 (USDA . . ., 1994a, page 341) indicated there are 9 known locations, but the 19 records in the Known Sites Database (version 2.0) represent only the 7 locations in Appendix A. The available records are in the elevational range of 244-853 meters (800-2800 feet), but this species could occur in both higher and lower elevations.

D. Habitat Characteristics and Species Abundance

Vespericola shasta seems to be restricted to isolated locations along the margins of streams where perennial dampness and cover can be found. Limestone in the alluvium of the streams of the upper Sacramento River system may contribute to habitat quality for this species. The relatively polished appearance of the shell of this species could be consistent with life in a stony environment (in contrast to other species of *Vespericola* that have a "furry" appearance and live on the soft surfaces of leaves and rotten wood on damp forest floors). Moderate numbers of this species seem to inhabit seemingly isolated situations, and there is no indication of a continuous distribution either in the relatively dry uplands or along the major rivers. Although this species may have had its distribution already fragmented by climatic change, the reservoirs, gold mining, and livestock grazing of recent centuries may have increased this fragmentation.

Habitat notes with the available records are as follows. The type series of 25 specimens was collected near Lamoine “almost in the water, under sticks and stones.” The adjacent land was “very dry” and no other land snails were found there (Berry 1921). A series of paratypes (CAS 80857) have the additional information “small rivulet to west of State Highway.” To better define the type locality, Cordero and Miller (1995) visited Lamoine and found only 3 snails along Slate Creek, which had steep banks, swift water, and offered little shelter at the water's edge, but they collected 20 along Little Slate Creek, which they decided was probably the stream from which the type series had been collected.

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At Flume Creek a small number of these snails was found under rocks and logs at the edge of the creek just upstream from Interstate 5 freeway. Along the shore of Burney Creek just below Burney Falls, moderate numbers were found under stones. At O'Brien Creek at least 12 snails were found under rocks close to the creek. Near Brock Creek 2 snails were found on a slope with a stream below a ridge labeled Gray Rocks (a local term for limestone).

Vespericola shasta seems to be scarce to moderately common where it does occur, but the known locations are few and widely scattered. Although it is under-surveyed, this species of land snail seems to be truly rare.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed under Survey and Manage Standard and Guideline

The Shasta Hesperian, *Vespericola shasta*, has a known range that is entirely within the range of the Northern Spotted Owl. In the FEMAT analysis (USDA . . ., 1993, page IV-129) this species was judged to have a 10% risk of extirpation under Option 9. One site is on Federal land in Shasta National Forest, and most of the apparent range is within the administrative boundaries of that National Forest. Although this species is sometimes moderately common where it occurs, it is known from few sites and seems to have a small geographic range, so this species seems to be truly rare and vulnerable to extinction if there were adverse modifications of inhabited locations.

B. Major Habitat and Viability Considerations

The major habitat and viability consideration for a rare species such as *Vespericola shasta* is the conservation of existing populations by positive management of identified areas of habitat. When contrasted to vertebrate species, mollusk populations are relatively sedentary. "If protected from catastrophes, snail colonies may not depend on immigration and could conceivably be self-sustaining for centuries, in which case the distance to the next fragment [of suitable habitat] may not be very important" (Roth 1993). "Even patches of a few hundred square meters could support "reservoir" populations if appropriate habitat structures . . . were maintained" (Roth 1993). What is most urgent is to identify occupied sites and then maintain appropriate structures and favorable conditions. However it should also be recognized that this species depends on the health of the local ecosystem that in turn depends on connectivity with adjacent communities, both terrestrial and aquatic.

C. Threats to the Species

Threats to the survival of the apparently isolated populations of *Vespericola shasta* probably include major changes to the local hydrology. These snails seem to depend on the availability of damp substrate and currently occupy the margins of streams. Therefore, any change to the watershed that results in decreased flow or increased instability of streams could contribute to the local extirpation of this species. Another possible threat is the reduction or removal of riparian trees, which may provide a favorable moderation of the streamside microclimate, may contribute hardwood leaves to the local food chain, may provide root channels and woody debris in which snails can find shelter during unfavorable weather, and may stabilize the stream banks. Other possible threats include the mechanical disruption of inhabited sites by livestock and any motor vehicles that are driven in, across, or along the edges of streams (including motorcycles and ATVs) and any projects that involve earth-moving machinery and efforts to build dikes or relocate stream channels.

Chemical pollution of inhabited streams could be a major threat to this small snail. This includes incidents such as the 19,000 gallons of metam-sodium that were spilled into the Sacramento River near Dunsmuir on July 14, 1991, and the cumulative impact of many small spills of petrochemicals and other toxic materials that could come from roads and railroads. It is inadvisable to store toxic materials or petrochemicals in watersheds with rare riparian species.

Nonnative species of plants and animals could disrupt local ecosystems and thereby threaten the survival of this rare snail. Weed species are difficult to remove once they become established. Finally, the extensive removal of vegetation from a watershed by wildfire, livestock grazing, or logging could result in both destructive floods and the loss of perennial surface flow.

D. Distribution Relative to Land Allocations

The only known location for *Vespericola shasta* on Federal land is in the Brock Creek drainage in the NE/4 of the SW/4 of section 9, T. 34 N, R. 2 W, Mount Diablo Meridian (location #6 in Appendix A). This site is in the Shasta Lake Ranger District of Shasta National Forest and is in the Whiskeytown-Shasta-Trinity National Recreation Area. Most likely these specimens were found within the Riparian Reserve of a western tributary of Brock Creek. In view of the apparent restriction of this species to stream margins, it seems probable that any newly discovered sites will also be within Riparian Reserves.

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The goal for management of the Shasta Hesperian, *Vespericola shasta*, is to assist in maintaining the viability of known and newly discovered populations of this species.

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B. Specific Objectives

Specific objectives for managing occupied known and newly discovered sites for *Vespericola shasta* on Federal land should include the following.

- conserve the cool and shady micro-climatic conditions as needed,
- conserve the availability of woody debris, rocks, and leaf mold,
- conserve the availability of herbaceous plants, moss, and ferns,
- conserve the perennial nature of the local spring or stream,
- conserve the quality of the water and the aquatic ecosystem, and
- avoid possible harm from chemicals, fire, and non-native species.

IV. HABITAT MANAGEMENT

A. Lessons from History

There seem to be no reports on populations of *Vespericola shasta* or of any other species of *Vespericola* that has been studied over a range of time, or over a range of environmental conditions, so that inferences could be drawn concerning population responses and limiting environmental factors.

B. Identification of Habitat Areas for Management

On the basis of the records and habitat information that were available as of August 1998, it is recommended that each occupied known or newly discovered site for *Vespericola shasta* that is on Federal land and is defined with adequate precision should be protectively managed by means of an identified Habitat Area. The Habitat Area will be identified as the area around known site locations that includes all habitat features that contribute to environmental conditions important to the species at the known site. The interagency ROD (USDA . . ., 1994b, beginning on the bottom of page C-4) advises that “in most cases, the appropriate action will be the protection of relatively small [Habitat Areas], on the order of tens of acres.” The study by Chen et al. (1995) found that on riparian south-facing edges the effect on soil temperature could extend 60 meters into the forest, and the soil moisture could be reduced 90 meters into the forest. If the conservation of microclimate at ground level is a concern, then the Habitat Area may need to be as large as 4 hectares (10 acres) in order to provide interior conditions at the known site. This particular species already seems to be challenged by natural conditions; however, if the landscape outside the Riparian Reserve does not currently nor can be reasonably expected in the future to positively contribute to the microclimate at ground level where the snails are living, then there may be no need to include it, and instead it may be preferable to identify a Habitat Area for this species as enough of the Riparian Reserve to provide favorable structural features, vegetation, and water quality at occupied locations. The width and length of such a Habitat Area should be guided by concerns for shading and wind buffering and could approximate the width of the Riparian Reserve unless greater distances are needed or a dimension must be limited to less because of land ownership or paved roads. Such a riparian Habitat Area should extend far enough upslope to adequately protect the spring or seep at the occupied location, or far enough upchannel to adequately protect the water quality and aquatic ecosystem of a stream reach where this species is known to live along the stream margins. If a colony of this species is found to extend for a distance along a stream, the Habitat Area should be expanded to encompass as much of this population as is allowed by ownership and topography. There is only one known location for *Vespericola shasta* on Federal land (#6 in Appendix A). Because this location is not precisely defined, it is suggested that the location be visited and surveyed for snails in order to identify the extent of an appropriate Habitat Area.

C. Management Within Habitat Areas

Management within Habitat Areas identified for the conservation of occupied known and newly discovered sites (colonies) of *Vespericola shasta* should use a cautious and protective approach. Maintenence of existing environmental conditions should include the following recommendations:

Prevent reduction of the existing canopy closure that could increase the exposure of these snails and their habitats to the drying effects of sun and wind. The structural composition of riparian hardwoods should be conserved or attained by natural processes.

Prohibit activities, including grazing by livestock and concentrated recreational activities, that could substantially degrade the herbaceous vegetation or water quality, reduce the quality or quantity of woody debris, disturb ground cover, or compact the soil at known locations.

Vehicles, horses, and livestock should be routed away from identified Habitat Areas in order to avoid crushing snails or degrading the quality of their habitat. If needed, suitable fencing should be constructed and maintained around Habitat Areas. Because all locations are below 1000 meter (3281 feet) elevation, the use of permanent fencing is preferable (if drop-fences were to be used, cattle might arrive before the wires were put up in the spring).

Management by means of fire or chemicals within Habitat Areas should be avoided, but the threat of wildfire to Habitat Areas should be managed by prescribed fire in adjacent areas.

Nonnative plants and animals should be removed by mechanical or biological means.

Water diversions, extractions, or other activities within occupied watersheds, which may alter the rate of flow of streams at occupied sites, should be regulated.

D. Other Management Issues and Considerations

Unlike most terrestrial mollusks, *Vespericola shasta* may be somewhat safe from being directly killed by fire because it seems to be confined to the wet margins of perennial streams. However, because of the risk of indirect effects, management by means of prescribed fire should not be applied within Habitat Areas identified for the conservation of this rare snail. The threat of wildfire to Habitat Areas should be managed by reduction of hazardous fuels in adjacent areas. The complete burning of a riparian corridor by a wildfire could result in the extirpation of a colony of this snail. It should be noted that chemicals used in fire suppression (detergents, etc.) may be harmful to this and all mollusks.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Northwest Forest Plan level.

A. Data Gaps and Information Needs

For *Vespericola shasta*, the distribution, ecology, life history, and responses to environmental changes all need to be explored. As noted by Berry (1996), *Vespericola shasta* has a shell that is very similar to the shells of *Vespericola rothi* and *Vespericola scotti*, 2 recently described species from this same region (Cordero and Miller 1995). If sets of diagnostic external features can be found and defined, then these 3 species can be distinguished in the field. Until a reliable suite of external characteristics are developed, the final identification of specimens of *Vespericola* from Shasta County may have to be done by an expert through the dissection of a sample of mature specimens, and protocol surveys and distributional studies will have to be guided by expert confirmations of all field identifications. Surveys may find this species to be limited to only a few locations, or that it is found at many locations. The range of this species should become better defined by mollusk surveys in the Mount Shasta and Shasta Lake Ranger Districts and the Shasta County part of the McCloud Ranger District in Shasta National Forest, the Hat Creek Ranger District of Lassen National

Forest, and the Shasta County part of the Redding Resource Area of NorCal Bureau of Land Management.

B. Research Questions

Did any populations of this snail survive the "Cantara Spill" of July 14, 1991?
Does this species occur together with any of the other species of *Vespericola*?
Does this snail range away from stream margins during wet weather?
Does this snail range away from streams where there is a closed forest?
Does this snail have any patterns of daily or seasonal movements?
How does *Vespericola shasta* respond to major fluctuations of stream level?
What are the food resources and natural predators of this mollusk?
Are there any features that could suggest the presence or absence of this snail?
Are there external characters that can be used to distinguish this species?

C. Monitoring Needs and Recommendations

The one known location plus any newly discovered sites for *Vespericola shasta* on Federal land, should be monitored (1) to assess compliance with the "survey and manage" standard and guideline, (2) to evaluate the habitat impacts of all management activities in and near these locations, and (3) to verify the continued existence of this species within each managed location. It is suggested that monitoring be limited at most locations to detecting presence no more than once a year and only when season and conditions are otherwise favorable for protocol surveys for terrestrial mollusks. Although rocks, woody debris, and leaf mold should be replaced as much as practicable, the limiting of monitoring to detecting presence is intended to minimize any degrading of the habitat. Searches following a no-detection should be done at different times of year during suitable conditions, as defined in the current survey protocol.

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APPENDIX A

The following annotated list of 7 locations includes all known records for the Shasta Hesperian (land snail), *Vespericola shasta*. In the Known Sites Database there are 23 records listed for this species. Four of those records do not represent this species and should be deleted (the invalid records have ID numbers 95000025, 97000105, 97000106, 97500009). The remaining 19 records are grouped into 7 locations in the annotated following list. The first location is the type locality, and the rest are arranged by the first date they were visited. After the location number (and record ID numbers from the Known Sites Database) there is a brief description of the location, the date(s) of collection, and the number of specimens (plus museum acronym or name of specimen holder and their catalog numbers). The annotation includes corrections and questions, an estimate of UTM coordinates, an estimate of elevation, the name of the USGS 7½-minute topographic map, an estimate of land ownership, and the level of precision code (plus the original code if one or more of the database records has a level that seems incorrect). In the Known Sites Database all records were graded as to how accurate the description of location seemed to be, and a code was entered in the "precision" field. The codes are S = "second record" (location is accurate to ±150 feet), M = "minute record" (accurate to ±1.5 miles), G = "general record" (accurate to ±5 miles), and V = "vague record" (cannot be located within ±5 miles).

> **#1** (90101803, 97000008, 97000011, 97000012, 97500019, 97600011, 97600012) **Type locality** — California, Shasta County, **Lamoine, Little Slate Creek**. 1920 [or 1921], August, 1994 April 13, and no date. A total of 52 specimens (SBMNH 34131, 34132, 142066, ANSP 130454, CAS 64117, 66414, 80857, DNHM 125641). Berry (1921) stated the type series was collected in August 1921 (his page 38) but that the trip was in the summer of 1920 (his page 35). Berry's publication was dated October 1921 but actually issued on 5 December 1921 (per Coan and Harasewych, 1993). Cordero and Miller (1995) reported that in April 1994 there were two creeks that emptied separately into the Sacramento River within 300 meters (984 feet) of each other and both were populated by this snail. They reported that Slate Creek had steeper banks and fewer snails, and the snails at Little Slate Creek seemed more polished-looking than those from Slate Creek, so they selected Little Slate Creek as the stream from which the original type series was probably collected. However, the USGS map was published before 1994 and shows Little Slate Creek flowing south (possibly diverted) along the west side of Interstate-5 and into Slate Creek about 200 meters (656 feet) before Slate Creek reaches the Sacramento River. Notches in the map contour lines suggest Little Slate Creek might have originally flowed through the village of Lamoine and entered the river independently at a point roughly 200 meters (656 feet) upstream from the present mouth of Slate Creek. Did Cordero and Miller collect from the old mouth of Little Slate Creek or were they west of the freeway? UTM are roughly 547800 E and 4536200 N; elevation is roughly 390 m (1280 ft); USGS map = Lamoine, CA, 1990; land is non-Federal (state or private); and the precision = M.

#2 (97000009) California, Shasta County, **Lamoine, Slate Creek**. 1994 April 12. Two specimens (SBMNH 142067). UTM are roughly 547800 E and 4535900 N; elevation is roughly 384 m (1260 ft); USGS map = Lamoine, CA, 1990; land ownership is non-Federal (state or private); and the precision = M.

#3 (97000007, 97000010, 97000107) California, Shasta County, **Flume Creek**. 1924 July 17, 1992 April 11, 1994 April 13. Eleven specimens (CAS 49684, SBMNH 78132 and 142076). The recent samples were from under logs and rocks at edge of creek just upstream from Interstate-5. This location is outside of the administrative boundaries of Shasta National Forest. UTM are roughly 554950 E and 4549400 N; elevation is about 580 m (1900 ft); USGS map = Tombstone Mountain, CA, 1986; land ownership is non-Federal (private or state); and precision = M.

#4 (97000004, 97000006, 97500005) California, Shasta County, **Burney Creek** just below Burney Falls. 1934 September 9, 1935 June 11, and 1959 June 16. Thirty specimens (FMNH 99823, SBMNH 7937 and unnumbered). Snails were under stones along shore of Burney Creek (Pit River tributary) just below the falls in McArthur-Burney Falls Memorial State Park. UTM are roughly 613500 E and 4540800; elevation is about 853 m (2800 ft); USGS map = Burney Falls, CA, 1990; land ownership is non-Federal (state); and precision = M.

#5 (97000005, 97500005) California, Shasta County, **O'Brien Creek**, 4 miles north of Baird. 1937 September 30, and no date. Twelve specimens (MCZ 63500, SBMNH 8670). This location and Baird are probably under the water of Shasta Lake (Shasta Dam was completed in 1945); now there is an O'Brien Creek Inlet in the Whiskeytown-Shasta-Trinity National Recreation Area (T. 34 N, R. 4 W), and Baird has not been located (not in USGS index). Possible elevation range is 244-366 m (800-1200 ft); USGS map = O'Brien, CA, 1990; and precision = G.

#6 (95000014) California, Shasta County, **Brock Creek drainage** in NE/4 of SW/4 of section 9, T. 34 N, R. 2 W. 1975 July. Two specimens (Roth 569). Near Forest Service Trail 1W21 and Brock Creek (Pit River tributary); Gray Rocks Ridge in the western part of section 9 suggests there is limestone in the substrate. This is the only known location for this species that is on Federal land (Shasta Lake Ranger District of Shasta National Forest and Whiskeytown-Shasta-Trinity National Recreation Area). UTM are roughly 575800 E and 4518400 N; elevation is roughly 427 m (1400 ft); USGS map = Devils Rock, CA, 1990; and precision = M.

#7 (95000068) California, Shasta County, **McCloud River canyon** 25 miles northeast of Redding. 1979 April 9. One specimen (Roth 1197). The McCloud Bridge is close to 25 airline miles from Redding, so this location is presumed to be within 5 miles of the McCloud Bridge. Possible elevation range is 325-427 m (1065-1400 ft); USGS map = Bollibokka Mountain, CA, 1990; and precision = G.